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THE STEAM TURBINE: THE STEAM ENGINE OF MAXIMUM SIMPLICITY AND OF HIGHEST THERMAL EFFICIENCY.*

By Robert H. Thurston.

The Steam Engine of Maximum Simplicity and of Ideal Thermal Efficiency would presumably be defined, by one familiar with the general principles of science—even if entirely ignorant of its applications of contemporary date in the heat-motors, mechanically—as a machine having a minimum number of moving parts and thermodynamically free from other wastes than those of the ideal thermodynamic machine. Such a machine has never been produced, and it is not to be expected that it will ever be constructed in perfection. Yet the close of the nineteenth century sees a remarkably close approximation to this ideal; and that, curiously enough, by reversion to an ancient type and by the reproduction, in refined form and proportions, of the "Greek idea of the steam engine," as illustrated by Hero in his "Pneumatica," 120 B. C., and in better type, though no better form, by Branca, in his "Machine deverse," of 1629.

The ideal construction is certainly reached in a machine in which there exists but a single moving element; and the ideal thermodynamic machine is approximated in a motor in which adiabatic expansion is secured, and friction and heat waste may be made sources of comparatively small loss. The elements of waste, conduction, and radiation, and incomplete expansion, are probably capable of large reduction, with improved construction and continued experience in the apportionment of the apparatus to its work. The main purpose of this discussion is to summarize the work of the steam turbine to date—as well as may be—and to study the sources of loss as it is now constructed and operated, and to deduce, if possible, the principles involved in its correct design, construction, and operation — meantime bringing out into relief facts indicating the essential importance of employing superheated steam in a machine in which it has seemingly no other than thermodynamic value, and of the use of condensation to enable the engineer to evade a loss and accomplish a purpose which have no counterparts in the case of the piston engine.

The Steam Turbine—known as a "reaction wheel" to Hero (120 B. C.) and the Greeks, and possibly long before the Christian era —proposed by Branca in 1629, in the type-form familiar to us in the hydraulic wheels of the Pelton class and the steam turbine of the Laval type, has only recently come to be considered seriously by the engineer as a practicable form of heat motor. This was not because its principles and its ideal efficiency were not known to him, for the principles of design, construction, and action are precisely the same as those of the hydraulic motors, and have been developed with the greatest elaboration by Weisbach and other early writers of our time, and have been applied in construction by the engineers of every civilized nation. It was not because no attempts had been made to utilize this class of motors; for, from time to time, ever since Branca, and especially within the past century, steam, as well as hydraulic, turbines have been built and experimentally used.*

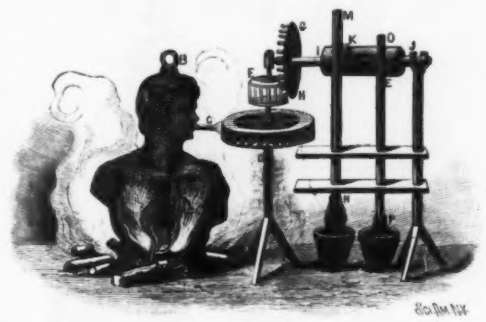
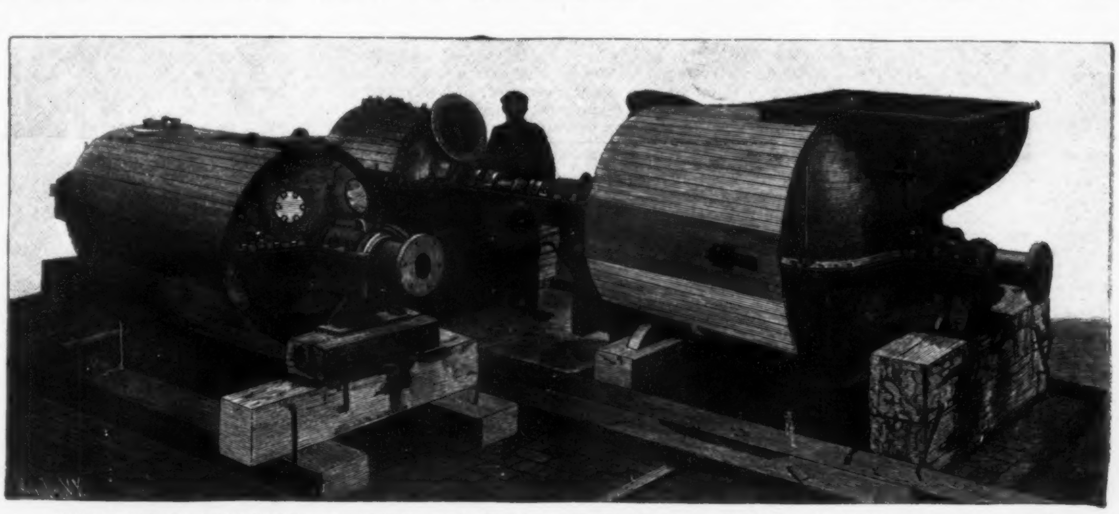


FIG. 2.—BRANCA'S STEAM-ENGINE, A. D. 1629.
(From "History of Growth of Steam-Engine," p. 17.)

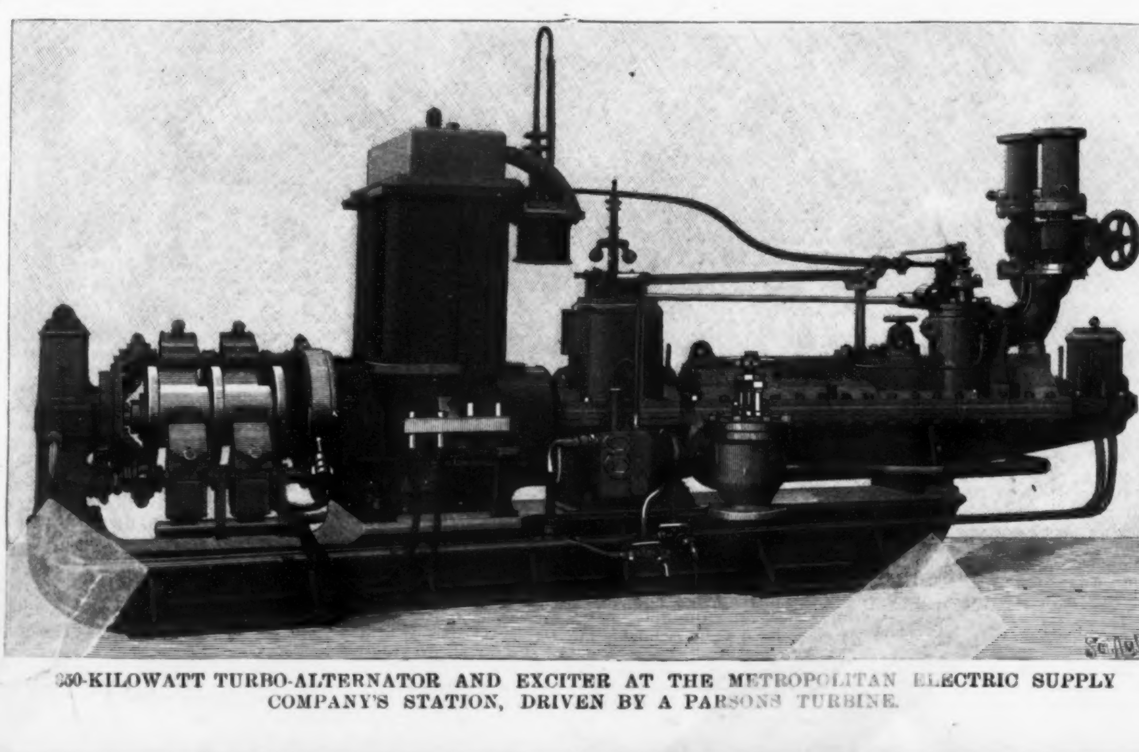
More than half a century ago, a steam turbine of the Hero form was built in Baltimore, by Atwater, which, with its comparatively large scale of construction, fairly well-proportioned arms, and generally excellent design, was found to give, as then reported, practically the same economy in operation as the ordinary steam engine of the time of similar power. Within the last twenty-five years, both the Hero and the Branca forms of turbine have been extensively introduced into the United States, and without attracting attention, either of the public or even of engineers, by the constructors of dairy machinery in their "cream separators" or "centrifugals," making from 6 to 8 thousand revolutions per minute or more in small sizes, and where no other direct acting motor is practicable. The result was an astonishing efficiency in many cases of good design; and the Branca form, particularly, exhibits such satisfactory qualities, as constructed by Laval for this use, as to make it a permanent and standard addition to our list of prime movers. Many inventors have attempted its perfection during the last years of the nineteenth century, and its efficiency has been brought up by Parsons, Laval and others of the more successful among them, to a very satisfactory figure, and it has come to seriously compete with the reciprocating engine in many directions in which high speed of rotation is allowable or desirable; although usually the steam turbine has a "best speed" as much above the highest desirable speeds of rotation of even fast-running machinery as that of the ordinary steam-engine is below; and "speeding down" is found as objectionable in many cases as "speeding up." The facts are, that the machine is as simple in construction as the reciprocating steam engine—especially in its multiple-cylinder forms—is complex; that it is comparatively simple in principle and inexpensive in construction, and that it may attain great economy in the use of steam and of fuel.

Rankine states that Mr. Ruthven brought a Hero turbine into use "to a limited extent" many years ago in Scotland, and that Mr. Wm. Gorman constructed an inward-flow turbine, which was set up and operated in the Glasgow sawmill, attaining as high an efficiency as "the ordinary high-pressure engine" — presumably meaning a non-condensing engine.†

The later "compound" steam turbine has recently been extensively employed in the operation of dynamo-electric machinery. It consists of two sets of parallel-flow turbines set, in twin series, on one shaft on either side the in-



THE STEAM TURBINES OF THE 35½ KNOT DESTROYER "VIPER," MAXIMUM INDICATED HORSE POWER, 11,000.



250-KILOWATT TURBO-ALTERNATOR AND EXCITER AT THE METROPOLITAN ELECTRIC SUPPLY COMPANY'S STATION, DRIVEN BY A PARSONS TURBINE.

* Paper read at the New York meeting (December, 1900) of the American Society of Mechanical Engineers.

* One of the earliest recollections of the writer was the construction of a Branca turbine by Messrs. Thurston, Green & Co. at Providence, R. I., on the order of an inventor named Schmidt, which was intended to develop a very considerable amount of power. In consequence, however, of the ignorance of its inventor and designer, its proportions and forms of details were altogether incorrect, and the machine as constructed was naturally a failure.

† "The Steam Engine," p. 538; 14th ed. 1897.

duction-pipe, thus balancing. The passages are gradually enlarged as the volume of the steam increases with its progressive expansion. The Parsons is the best-known form.

The turbines thus alternate with their guide blades, and both the vanes and the blades are carefully proportioned and set to secure maximum attainable efficiency at the proposed speed of rotation, their pitches and depths being suitably varied.

The computed efficiency, without allowances for wastes, is about 87 per cent. The actual consumption of steam is found to be 16 to 26 pounds per electrical horse-power produced, and per hour as steam-pressures rise from sixty or eighty pounds by gage upward to several hundred. The speed of rotation ranges from 2,000 or 5,000 revolutions per minute upward, according to size and steam-pressure; 15,000 and 20,000 being common speeds for the smaller sizes.

Dow's turbine is an inward-flow wheel with concentric sets of guides and vanes in series, and is said to have attained 35,000 revolutions per minute, working regularly at 25,000, consuming 45 pounds of steam per horse-power per hour. Only the most perfect construction is admissible in any turbine.

The theory of this type of machine is that familiar to the hydraulic engineer, and the speeds of orifice for maximum efficiency are well known to be infinite in the Hero class of turbine and approximately one-half the final velocity of flow in the guide-blade turbine. Since these speeds are impracticable a certain loss of energy is thus inevitable. In compensation for this loss, in the steam-turbine, is the fact that it is not subject to that fluctuation of temperature of parts exposed to contact with the steam which results in large wastes by cylinder-condensation in the common forms of steam engine. A gain of from 25 to 50 per cent, as compared with the latter, in this way, is to be counted upon.

The Dow turbine, as built for work in connection with the Howell torpedo, gives an average of about 11 H. P. in coming up to speed in regular working, at 60 pounds steam-pressure, and weighs from 100 to 150 pounds, or not far from 13 pounds per horse-power.* Its fly-wheel rim attains a speed of nearly 7 miles an hour at 10,000 revolutions per minute. The designer estimates its power at 150 pounds steam-pressure and the same speed at 40 H. P., or one horse-power to 3.75 pounds weight, and states that this may be still further reduced to the extraordinary minimum of 2¼ pounds weight per horse-power, a figure within the estimated allowable maximum for use in aeronautic work.

The steam turbine of Parsons, Fig. 3, is an engine consisting of two series of cylindrical turbines, arranged symmetrically, right and left of the central steam-inlet, the exhaust taking place from the two ends. In this manner, a balance is obtained, and the bearings are relieved of end-pressure. Oil is forced through the bearings by a pump. This engine has driven a torpedo boat 100 feet long and of 44½ tons displacement at the rate of 32¾ knots, developing 2,100 H. P. with machinery weighing, with water in the boilers, 22 tons, thus producing 100 H. P. per ton and 50 per ton of displacement.

Such engines have been successfully employed in driving electric machinery and in "spinning" the "fly" of the Howell torpedo. For alternating electric currents, this system possesses the peculiar advantage of permitting a "dynamo" to be employed having but two poles. It may be readily driven continuously at speeds exceeding 10,000 revolutions per minute, and, like the Dow turbine, has been driven at 20,000 and upward. With the lower speeds of revolution usual

where p_1 lies between 50 and 200 pounds per square inch by gage, and the apparatus is operated under favorable conditions; the value of a lying between 200 and 300 with dry steam.

In the United States, the substitution of the Dow turbine for the systems previously in use, for spinning torpedoes, has brought down the weight and volume of machinery from the earlier minimum of 360 pounds and three cubic feet per machine to 55 pounds and one cubic foot.

In the steam turbine, either the common direct-flow turbine or a "scroll wheel" of the Whitelaw type, in

HERO'S ÆLIPILE.

which the reaction of the current develops an amount of energy which approaches the ideal maximum as the speed of rotation and of the discharge orifices increases, within practical limits, the design, as of nearly all peculiar forms of engine, is a subject of no great difficulty, all the principles which have been given applying to them as to ordinary engines. The design type involves merely the determination, first, of the maximum speed or rotation practicable, and next, the diameter permissible. These points settled, the wheel is given a general form such as will least affect efficiency by its friction resistances, either on its journals or in the air, and a size of orifice such as will discharge the required weight and volume of steam at the pressure fixed upon. In some cases, compounding has been resorted to, to reduce the speed of rotation for high efficiency, with good results. Properly designed and operated, these machines should give quite as high efficiency as the small engines which they are intended to compete with.

It is an interesting and curious fact that this earliest of all steam engines, antedating James Watt nearly 2,000 years, should have a higher ideal efficiency than the best of modern engines.

A common speed is that which makes the velocity of orifice equal $v = \sqrt{2\,gh}$, that of exit of the steam, where h is the height due the work of expansion to zero-pressure.

The speeds of the steam turbines thus enormously exceed those of any form of engine with reciprocating piston, or even of the so-called rotary engines. The three- and four-cylinder engines of the Brotherhood type, in which the several cylinders are usually grouped radially about a common crank and shaft, often exceed 1,000 revolutions per minute and have been driven, experimentally, above 2,500; but the steam turbine of Parsons makes 10,000 and even 20 000 revolutions and the Dow turbine is reputed to have attained 25,000, in small sizes.*

Advantages claimed for the steam turbine of good construction, as stated by Mr. Parsons, are, for the marine engine:

1. Increased speed.
2. Increased economy of steam.
3. Increased carrying power of vessel.
4. Increased facilities for navigating shallow waters.
5. Increased stability of vessel.
6. Increased safety to machinery for war purposes.
7. Reduced weight of machinery.
8. Reduced space occupied by machinery.
9. Reduced initial cost.
10. Reduced cost of attendance on machinery.
11. Diminished cost of upkeep of machinery.
12. Largely reduced vibration.
13. Reduced size and weight of screw propellers and shafting.

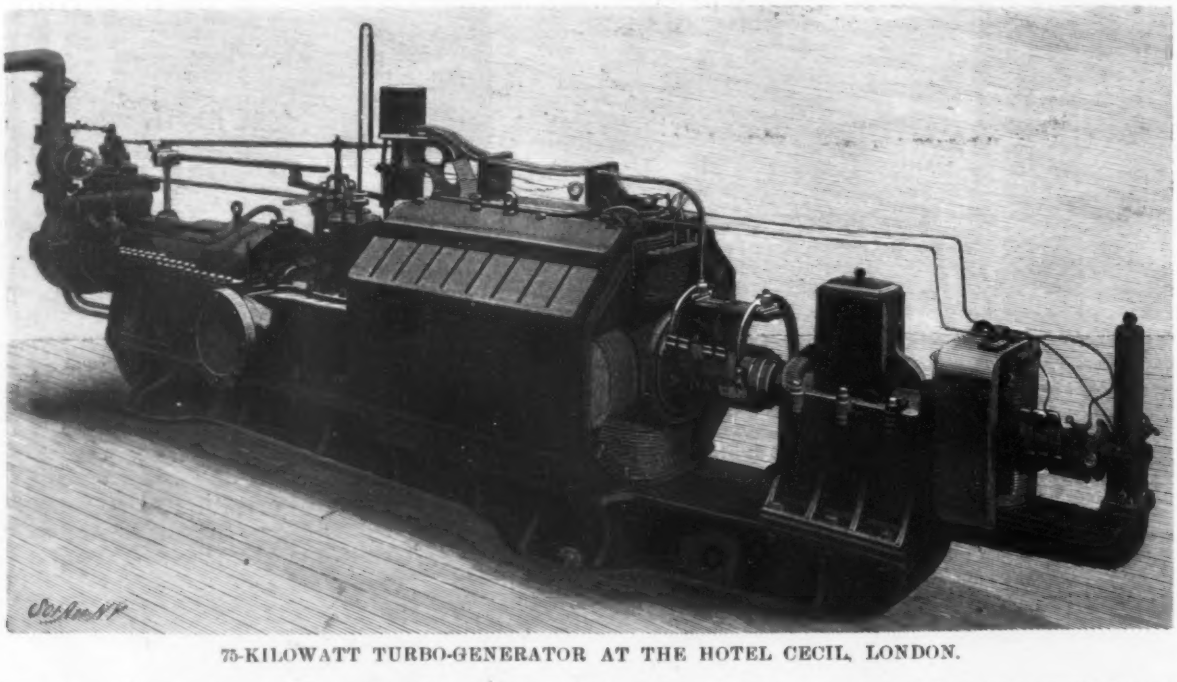
Prof. Ewing concludes:

"The application of steam turbines to torpedo boats, destroyers, gunboats and cruisers, is to be anticipated from their unique capacity for developing great power and high speed with light and compact machinery. Apart, however, from these uses, it appears to me highly probable that they will in time be adopted in the mercantile marine. The conditions in a fast passenger steamer are favorable to the economical application of steam turbines, and in such steamers the smoothness of their running will be a strong recommendation. I see no drawback likely to detract from the advantages which they plainly possess."

Experience already had with this motor leads Mr. Parsons to assert:

"The application of the steam turbine principle to fast ships in general, including passenger vessels, Atlantic liners, and ships of war, would appear to present no special difficulties. It may be said, generally speaking, that the larger the scale on which the engines are made, the simpler is the construction, the higher the steam efficiency, and the lower the speed of rotation."

The Rotary Steam Engine, the "steam wheel," as Watt called his patented form of this machine, does not seem to promise rivalry with either the reciprocating engine or the turbine. It is apparently incapable of securing the essential requisites of successful application in such extent and perfection as to give it place in the general market for prime movers. It is almost invariably subject, with continued use, to serious leakage, a waste which may be made practically insensible in either of the other machines; it can rarely, if ever, be made to regulate with satisfactory certainty and exactness; it seldom, if ever, gives entirely satisfactory expansion of steam, and it has



75-KILOWATT TURBO-GENERATOR AT THE HOTEL CECIL, LONDON.

with ordinary engines, the number of poles required generally approximates the quotient 12,000 divided by the speed of engine, if directly connected.†

The best of these machines have demanded from 16 pounds of steam per horse-power per hour, upward, according to pressure employed and amount of superheating. It may be assumed that they will require not far from the weight, for large powers

$$W = \frac{a}{\sqrt{p_1}}$$

* Electrical World; April 18, 1891.

† "Manual of the Steam Engine," vol. ii., pp. 62, 225.

The ideal efficiency of the reaction wheels is, as shown by Rankine,*

$$E = \frac{2\,ar}{\sqrt{2\,gh}\left(\frac{ar}{2gh} + \sqrt{1 + \frac{ar}{2gh}}\right)}$$

where a is the angular velocity, r the radius to the orbit of the orifice, and h is the height due the velocity of outflow of the fluid, and E approaches unity as the value of $a\,r$ approximates infinitely. At a speed of orifice equal to that of outflow of similar steam from a fixed orifice, the efficiency is about 0.7.

* "Steam Engine," p. 190, § 176.

not yet been found practicable to unite the elements of economical operation with those of precise adaptation to the work, as illustrated by the arrangement in the reciprocating engine, in which the governor determines that adjustment by regulating the ratio of expansion.

The best rotary-engine work with which the writer is acquainted is that of the Noteman engine, of twenty years ago nearly, in which, when developing 125 H. P. on the brake, 15 were measured by the indicator; the

* Trans. A. S. M. E., vol. x., 1889, p. ... For much of the above and other data relating to the high-speed motors, see "Manual of the Steam Engine," vol. i., pp. 237-241; vol. ii., pp. 158-160.

speed being 350 revolutions per minute and the steam-pressure 60 to 80 pounds; the ratio of expansion was very nearly 2, as shown on the diagram, but more nearly 1.5 in fact, clearances being considered. It was subject to a loss of about 25 per cent through internal condensation—a small figure, however, for the size of engine. A variety of other rotary engines, tested by the writer or the work of which has been reported to him, have demanded, on the average, not less than three times as much steam; this engine consuming 43 and the others about 156 pounds per horse-power hour; the latter, however, not being considered a very extravagant record for reciprocating engines of minimum power. The most inefficient of the rotaries demanded about 400 pounds per horse-power hour.

This class of engines, as a rule, if not invariably, is restricted, by its complication of valve-gear and the system of movable abutments within its cylinder, to comparatively low speeds of rotation, the turbine being the standard taken. The reciprocating engine can usually compete with its standard.

The Steam Turbine is, in essence, economical through its simplicity and the directness which distinguishes its method of thermodynamic energy-conversion. It is subject to small loss of mechanical efficiency through friction of journals, it having but a single pair of rubbing parts, bearings of small diameter, although of enormous speed of revolution, and it is entirely free from the great source of waste in the reciprocating engine, that internal variation of temperature of metal-surfaces which, ranging from the temperature of prime steam to that of the exhaust, nearly produces wastes amounting to from 10 per cent to sometimes 50 and more of the heat, steam and fuel supplied. In the steam-turbine, the internal surfaces, while it is in steady motion, are, in all parts, at a constant temperature, and that is the temperature, practically, of the steam in contact with the element of surface. Its only thermal loss is by conduction and radiation, and that may be made very small. Its thermodynamic losses are due, as in other steam engines, to incomplete expansion within the wheel and discharge of the fluid with considerable energy of mechanical motion through malproportion, maladjustment or lack of adaptation of the speed of discharging orifice to the velocity of the expanding, rejected fluid in such manner as to reduce its velocity of rejection, into the air or the condenser, to a minimum.

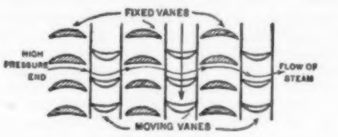
It is, however, subject to one form of loss which does not seem to have been generally, if at all, recognized, and one which may prove to be serious, partly in its reduction of efficiency and largely in its reduction of power, particularly of small turbines. This is the friction of water or of moisture-laden steam within the passages of the turbine and, especially, between the turbine and casing, either by direct obstruction, where a film, a thread or a mass of water lies in contact with both wheel and casing, or, indirectly, as when water drips or flows, from comparative quiescence, on the casing to take up high velocity and large amounts of energy, by riding on the wheel.

The number of steam-turbines brought out by inventors in recent years is very large, although the opportunity for radical improvement or for original invention, in its main features of construction, is small. All belong to either the Hero type of 2,000 years ago or to the Branca type of 1629.* In all cases, the principle is precisely the same, so far as the action of the steam is concerned, and in the thermodynamic operation of production of dynamic from thermal energy; the differences lie in the devices employed for steam-supply, for reducing speeds of rotation of the driven shaft, and for regulation and adjustment of power to load. The literature of the subject is not extensive and, in fact, the simplicity of the principles and of the practice in this case permits comparatively little opportunity for extensive discussion of either.† The number of patents, on minor and usually unimportant details, is very considerable (270 in the United States to date) and the reported experimental work, in measurement of power, efficiencies and other essential engineering data, is large and increasing in volume. There is already quite enough to supply the needed material for our present discussion of the importance of superheating in promotion of efficiency and in its reduction of friction. In all, also, the process is the same; the conversion of the energy of heat stored in the steam into the kinetic energy of a jet; from which jet this energy is absorbed by intercepting it at the turbine-vane and gradually transforming its *vis viva* into work while changing its path until, with complete reversal of direction and with velocity nearly destroyed with respect to the earth, the fluid issues at minimum velocity and with minimum unutilized, available thermal or dynamic energy.

Parsons' Compound Steam Turbine dates from 1884.‡ It is now the most extensively employed of the motors of this class, and has been constructed on so large a scale and of such high powers as to afford a very satisfactory set of data by which to judge of the promise of the type.

The first example of the machine ran, for some years, at a speed of 18,000 revolutions per minute; the second at about 10,000, driving a generator and providing current for the 60 lamps of the steamer "Earl Percy," on the Tyne. Mr. Parsons, in 1888, reported the efficiency of each element of his compound turbine as "theoretically" 89 per cent and their combined efficiency as 87 per cent; the passages in guides and turbines being properly proportioned, to avoid the breaking up of the steady flow and continuous expansion of the steam. With careful lubrication, no wear was perceptible after several years of continuous working and no cutting action by the steam upon the parts of the machine was detected. The friction of bearings was found to be, at speed, over one-third of a horse-power each, cold, *but less than one-fifteenth when hot.* The normal output of the electric generator was 400 amperes at 80 volts, with a resistance of but 0.0025 ohm, in the armature, from brush to brush. The resistance of the field magnets was 23 ohms; electric efficiency 98 per cent, with 32,000 watts delivered, the engine working non-condensing; the steam consumption was 42 pounds per electrical horse-power per

FIG 6.



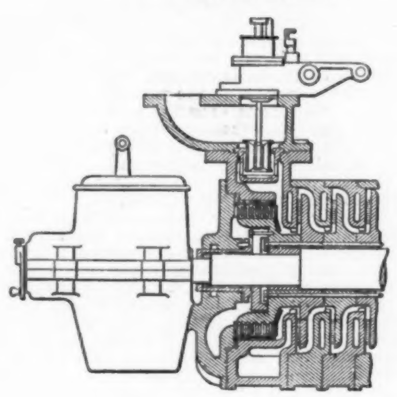


FIG. 7.

hour with 61 pounds steam pressure at the inlet and 35 pounds at 92 pounds pressure; the latter figure being practically equivalent to about 25 pounds per indicated horse-power per hour for a reciprocating engine. Since the date of that introductory report, the figure has been much reduced, as shown elsewhere in this paper. At such speeds, as was to have been anticipated, the light and current were absolutely steady; there was no equivalent of the numerous minor forms of breakdown and accident only too familiar to us in the use of the reciprocating engine; costs were small, both of construction and of operation, and weight and volume small per unit of power. In four years after its inception the turbine had been supplied in an aggregate of over 2,000 electrical horse-power.

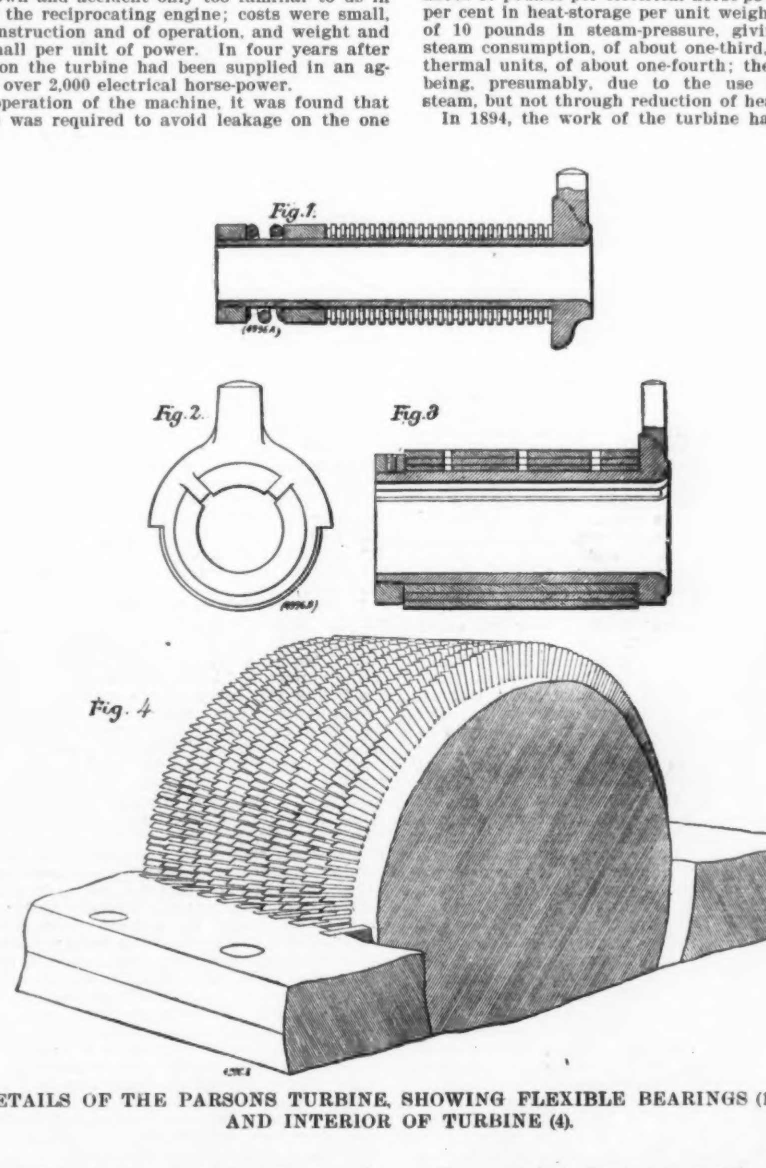
In the operation of the machine, it was found that much care was required to avoid leakage on the one hand and friction on the other. Leakage was the principal cause of waste in the earlier forms, although clearances had been reduced to about 0.015 inch, permitting a loss of about 20 per cent in a 50 H. P. machine. The actual efficiency was about 60 per cent; that of the generator attached was 95 per cent. The ideal engine should, under similar circumstances of operation, non-condensing, give the horse power hour on about 18 pounds of steam, about one-half that actually at the time attained (1888). In these pioneer machines, ground spindles and journals, yielding bearings and forced lubrication were employed, and the probable value of the machine as a compressed-air motor was recognized in the discussion of the time. The method of flow of steam, from vane to vane, is shown in the annexed sketch.

The design of the Parsons Turbine illustrates that scientific method which distinguished the work of James Watt and of others among our most famous and successful inventors of recent times. As stated by Mr. Parsons, the need was at the time recognized for a fast-running engine of fair economy in electrical work and "the advantages of a steady running engine having no reciprocating parts, of small size and of extreme lightness were sufficiently obvious; provided that fairly economical results as to steam consumption could be realized."

The efficiency of the hydraulic turbine, which involves the same mechanical principles, gave promise of at least fair mechanical efficiency in the steam turbine, and the apparently thermodynamic equivalence of the turbine and the piston engine, and the fact that the former is entirely free from the most serious of the extra-thermodynamic wastes of latter, gave assurance of good economy in heat-conversion if the turbine could be practically operated in accordance with known principles of maximum efficiency. To keep down the speed of rotation, the turbine was compounded and a series of turbines was set on a common shaft, through which the steam passed successively, producing in each a thermodynamic effect proportional to the magnitude of that portion of the head availed of at each step, until the final element of the series ejected the steam into the air or into the condenser. The rotative speed was thus reduced in proportion to the number of turbines in series and the total thermodynamic efficiency was that due the total effective head and the net efficiency that due the thermodynamic operation, less friction and leakage wastes and the slight waste by conduction and radiation of heat.

The Parsons turbine was so far perfected in 1892 as to exhibit, in a trial reported upon by Prof. Ewing, an economy measured by 27.6 pounds steam per electrical horse-power per hour, at 95 pounds pressure. Later, the same authority reported upon a similar turbine, in fact the same with alterations to adapt it to the higher pressure employed, 115 pounds, and with superheated steam, 60 degrees F. above the temperature of saturation. This test gave a steam-consumption of about 20 pounds per electrical horse-power—a rise of 3 per cent in heat-storage per unit weight of steam, and of 10 pounds in steam-pressure, giving a profit, in steam consumption, of about one-third, and in British thermal units, of about one-fourth; the principal gain being, presumably, due to the use of superheated steam, but not through reduction of heat-wastes.

In 1894, the work of the turbine had been so well and so satisfactorily tested, and the outcome had given such practical experience in designing, in construction and in operation, as to justify those interested in the new motor in seeking its experimental development on a larger scale. A syndicate was formed



DETAILS OF THE PARSONS TURBINE, SHOWING FLEXIBLE BEARINGS (1, 2, 3) AND INTERIOR OF TURBINE (4).

* Hero's "Pneumatica" (B. C. 120); Woodcroft's Translation, 18—, "Le Machin deverse del S. Giovanni Branca," Rome, MDCXXIX. Stuart's "History of the Steam Engine," London, 1824. Thurston's "History of the Growth of the Steam Engine," International Science Series. New York, London, Paris and Leipsic, 1878.

† See Ludwig Klein in Zeits. des Vereines Deutscher Ingenieure, October, 1895; Revue de Mecanique, vol. vii., 1900.

‡ "Description of the Compound Steam Turbine and Turbo-Generator," by the Hon. Charles A. Parsons, Proc. Brit. Inst. Mechanical Engineers, August, 1888, p. 480.

to test it in marine work and a boat was built to develop high speed, and to secure determinative measures of the value of steam turbines in driving the screw-propeller.

The first outcome of the experiment on the "Turbinia" was the discovery of a previously unsuspected cause of inefficiency at high speeds of rotation of the screw such as were adopted in this construction—"cavitation" by centrifugal action about the screw, which worked in a self-created cave in the midst of the water, throwing out the water faster than it could flow into the space by the action of gravity, even reinforced by the often still more active tendency to fill the vacuum thus caused. It was only when the speed of rotation of the screws had been reduced to 2,000 revolutions per minute, and after they were set in series of 3 on the same shaft, that the little boat made her famous run and attained a speed of 32¾ knots an hour, and later of 34½.

Trials of the "Turbinia" were reported on by Prof. Ewing, thus:

"The mechanical friction of the turbines is particularly small, and the work spent on friction is not materially increased by increasing the range of expansion. This allows the steam to be profitably expanded much farther than would be useful or even practical in an engine of an ordinary kind. Apart from questions of friction, the addition of weight and bulk to allow for this extended expansion would be enormous in the ordinary engine; in the turbine it is very moderate. Steam is expanded nearly two hundredfold in the 'Turbinia,' and this is accomplished with engines which are much lighter than reciprocating engines of the same power, although in these the expansion would be much less complete. Rough weather was met with in some of the trials, and I had the opportunity of seeing that the 'Turbinia' is for her size a good sea-boat. The machinery worked with perfect smoothness; the screws did not race, and the bearings remained perfectly cool throughout. From first to last, during the whole of the trials, there was no hitch whatever or difficulty of any kind in the action of the turbines. Some twenty trial-runs in all were made under various conditions as to speed; the range of speeds tested extending from 6¾ knots to 32¾ knots. Full-speed trials were made on April 10; the boat having then been in the water for fully a fortnight. Two successive runs on the measured mile, in opposite directions, in smooth water and at the slack of the tide, gave the following data:

Trial of "Turbinia."

Time on the mile	109 4-5 secs.	110 secs.
Corresponding speed in knots	32.79	32.73
Mean speed in knots	32.76	
Revolutions per minute of high-pressure and intermediate shafts		2,230
Revolutions per minute of low pressure shaft		2,000
Steam-pressure in boiler by gage		210 lb. per sq. in.
Steam-pressure on admission to high-pressure turbine		157 lb. per sq. in.
Greatest pressure in stokehold by water-gage		7¼ in.

"The speed reached during this trial, 32.76 knots in the mean, is, I believe, the highest yet recorded for any vessel. It is greatly in excess of the speed hitherto reached in boats so small as the 'Turbinia.' It is clear, then, that the exceptional speed developed in the 'Turbinia' has been achieved without sacrifice of economy, and that the substitution of turbines driving high-speed screws, in place of reciprocating engines driving screws of much more moderate speed, is not attended with increased consumption of steam, so far as fast running is concerned."

The success of the "Turbinia" led to the construction, in 1899, of a naval "torpedo-boat destroyer," "Viper," and this craft, only 210 feet in length, of 375 tons displacement, developing 11,000 horse power, on 15,000 square feet of heating, and 376 feet of grate surface, in water-tube boilers, with steam at 175 pounds by gage, at 1,050 revolutions of the turbines, made over 37 knots, above 43 miles, an hour. The contract speed was 35 knots. The turbines were two high and two low pressure, each driving a separate shaft carrying two propellers. The turbines were 35 and 50 inches in diameter. No vibration was produced by the engines, and the engine room was so quiet that it was hardly possible to realize the presence of engines developing over 10,000 horse power. Here, as in all craft of the sort, the extraordinary performance in power production, once all is understood, is that of the boilers; that of a horse power for each 1½ square feet of heating surface, and from each square foot of grate about 30 net horse power. This is probably the most extraordinary phenomenon in this or any other example of marine engineering.

Steam turbines of great size and power are likely soon to be produced for many purposes, now that their performance has been found so satisfactory, and especially for torpedo-boat work, and their construction on a large scale will enable the engineer promptly to settle many questions of interest which the earlier work on small machines could not fully solve. It would seem that, as with the gas engines, the larger the scale of operation, the simpler the problems of design and construction and the easier the approximate of the real to the ideal in perfecting the system of energy conversion. Large turbines are comparatively low in speed of revolution, and it is considered that it would be entirely practicable to build an ocean steamer of large size, driven by turbines of 30,000 or 40,000 high pressure, or more if needed, at speeds of revolution as low as 400 per minute or lower, employing four shafts and eight screws, requiring minimum steam and fuel for their work, while economizing enormously in space and weight. There would be no vibration or noise annoying to passengers, and their simplicity of construction and freedom from the multitudinous bearings of the now usual construction of engine would give insurance against either breakdown or minor troubles and delays from heated journals, leakages about the engine, or other annoyances and expenses inseparable from the reciprocating machine. Steam pressures can be adopted at the maximum practicable with the steam-boilers of contemporary practice, whatever the limit may be. That limit will thenceforward always be found at the boiler.

The general theory of the steam turbine is simple and is precisely that of the piston engine, so far as its thermodynamics are concerned. In both engines, the heat stored in the fuel is transferred to a liquid which it converts into vapor, the heat itself being transformed into the latent heat of internal and of external work, in large part, and in lesser part transferred without transformation as the added sensible heat of the forming steam. The work of the period of vaporization consists of that of separation of the molecules of the liquid, the internal work, and of the expansion of the fluid, from the specific volume of the liquid to that of the steam, against the superincumbent steam pressure with displacement of a corresponding volume of steam from the boiler through the turbine. This change is succeeded by expansion from maximum to minimum pressure, practically adiabatically; for the temperature of every element of the inclosing metal is constant, and equal to that of the steam in contact with it, throughout the whole period of steady operation, and all the work of adiabatic expansion takes effect in the acceleration of the steam in the jet. The pressures and volumes have the same relation throughout this period of acceleration in the nozzle as behind the piston of a reciprocating engine; the law of Newton, "action and reaction are equal and opposite," automatically adjusting the resistance of acceleration to the instantaneous value of the steam pressure at every point in the path of the jet through the nozzle. The cycle diagram of the turbine with complete expansion, whether simple or compound, is thus precisely the same as that of the ordinary engine of similar initial and back pressures and of equal ratio of adiabatic expansion; the latter being assumed possible, for the ideal case at least.

The reaction turbine and the impact turbine have this in common: that both convert heat-energy into work by the same thermodynamic process and both exhibit the same phenomena of steam production and utilization, thermodynamically. They have this difference: that the former accelerates the jet of steam actuating it, by its own rotation, and by the action of centrifugal force, and in such manner as to compel a higher resultant speed for a stated efficiency and such as to make the velocity of orifice, for unit efficiency, infinite; the velocity of the jet relatively to the nozzle is also infinite while falling to absolute velocity zero; while the impact due the steam pressure jet at the maximum velocity due the steam pressure behind it, simply, and steadily reduces that velocity to a minimum. The mathematical theory of both cases is perfectly well established and familiar, and need not be here recapitulated, so far as the non-thermodynamic mechanics of the problem are concerned.*

The impact turbine is that form in which the engineer finds most promise and its study is worthy of some attention. Its ideal thermodynamic cycle, as already seen, is that of the piston steam engine and modifications in practice are or may be the same, with the very important exception that the expansion line of the diagram may be always taken as adiabatic, but ideal being here attained—an impossibility with any other known form of steam engine or heat motor. The terminal and back-pressures may correspond to those of either the condensing or the non-condensing engine and the perfection of the diagram and of the cycle which it illustrates involves, as with the ordinary form of engine, the adoption of compression to an amount, in the case of incomplete expansion, proportional to the expansion, making the two ratios of expansion and comparison equal, and, in the case of complete expansion, restoring the fluid by complete compression to maximum temperature and pressure in the liquid state by mechanical means solely; thus, in fact, producing the Carnot cycle.

The first discussion of the steam turbine, from the point of view of applied mechanics, known to the writer, is that M. Tournaire, who, in 1853, stated the problem and the conditions leading to its satisfactory solution in a very clear and comprehensive manner.† He says:

"The elastic fluids acquire enormous velocities under the action of very feeble pressures. To utilize these velocities conveniently, with simple wheels like the hydraulic turbines, it is necessary to adopt an extraordinary rapid rotation, and to make the total section of the orifices very small, even for large deliveries of fluid. These difficulties may be evaded by causing the vapor *or the gas* (the italics are inserted by the translator) to lose its tension in a continuous and gradual manner, or by successive fractions, and making it react several times on the vanes of turbines properly arranged."

He then proceeds to illustrate by describing a series turbine, of the axial type, passing the steam through a succession of guide curves and turbine disks, alternately, from the high to the low pressure side, substantially as practised by Parsons a generation later when "reducing the invention to practice," as Tournaire seems never to have done. This pioneer of 1853 proposes not only a series turbine, but a series of these machines, where the range of pressure may justify such complication, each multiple turbine discharging its steam at the limit of its expansion into the next turbine of a similar construction, but in structure entirely independent, and so on to the atmosphere or the condenser, precisely as the multiple cylinder or series steam engine may be made of a series of independent engines arranged to pass the steam from the boiler through one after the other, from smallest to largest between boiler and condenser. He further describes very clearly the sources of losses "tending to diminish the useful effect, as leakage, irregular flow, shocks, *tourbillonnements*, at entrance of the fluid into the guides and vanes, fluid friction in the channels, which may absorb a very notable part of the theoretic work." "Great care and precision" must be observed in the construction of a turbine to be actuated by a fluid of high tension and small density, and the lines of flow must be thoughtfully considered. The teeth of gearing employed at these immense velocities of rotation should be skillfully made, and it is probable, as he states, "that the helicoidal gearing of White may prove best," a form actually utilized by Dow many years later, and by Laval still later.

(To be continued.)

* See "Thermodynamics of Heat-Motors and Refrigerating Machines," by De Volson Wood; §§ 157, 158; pp. 300-317, for discussion of the turbine.

† "Comptes rendus de l'Académie des Sciences," March 28, 1853.

THE POLLAK-VIRAG TELEGRAPH.*

By Herr Pinter, Director of the United Electrical Company, of Budapest, in Engineering.

In the Pollak-Virág fast telegraph system, the receiver differs essentially from the receivers employed up to the present, not only in principle, but even in construction. The currents, which are sent out automatically by means of a perforated slip, are directed at the receiving station, into a telephone, the membrane of which is provided with a small concave mirror operating in an extremely simple and ingenious manner.

Fig. 1 shows the connection of the mirror with the membrane. The small mirror is held to a permanent magnet by means of a small plate of soft iron fixed to it. One of the poles of this permanent magnet terminates in two points, while the other pole carries a mobile spring, which is also furnished with a point. Resting upon these three points the small mirror is held magnetically. The movable point is also attached by means of a tiny rod to the membrane of the telephone. The vibrations of the membrane communicate to the small mirror a corresponding movement, the two fixed points forming an axis of rotation. The rays of a small incandescent electric lamp are concentrated by the concave mirror upon a sensitized paper. The incoming currents cause the movement of the telephone membrane and also of the small mirror joined to the membrane; and the light-ray is consequently displaced in an upward or downward direction according to these incoming currents. If during this time the sensitized paper is moved in a horizontal direction, we shall find upon the paper, after development, a zigzag line, reproducing exactly the effects of the incoming currents. The alphabet employed is the well-known Morse alphabet, a displacement in an upward direction corresponding to a "dash," and a displacement in a downward direction corresponding to a "dot" of this alphabet, exactly as in the syphon recorder. One of these signals is produced by a positive current, and the other by a negative current. The telephone is known to be a very sensitive and fast apparatus, and consequently the signals can be transmitted at an exceedingly high speed, the receiver responding to them with the greatest precision. But, in order to secure the desired exactitude, it is necessary to annul on the one hand the injurious influence of the line, and on the other hand the disturbance caused by the proper vibration of the membrane. It is known that the result of the capacity, the self-induction, and the resistance of the line, is to retard the currents. By means of a self-induction coil of suitable dimensions, joined in parallel with the line at the transmitting station, the disturbances are avoided. Immediately on the cessation of each current, a current in the opposite direction is sent into line by the self-induction coil. By means of a condenser joined in parallel with the telephone at the receiving station, the self, or proper, vibration of the membrane is also eliminated in very simple manner. By employing a receiver, such as has been described, combined with the connected condenser and self-induction coil, it is possible to send telegrams over very long lines at a speed exceeding 70,000 words per hour. This has been completely demonstrated by trials made in the presence of competent representatives of the Telegraph Administration and other experts.

In the month of September, 1899, trials were made on an established telephone line, with a length of 1,050 kilometers, connecting Budapest and Berlin. With great ease we were able to transmit 70,000 to 80,000 words per hour. The tension of the current was 12 volts and the resistance 3,400 ohms. Encouraged by these brilliant results, the inventors, during a visit they made to America, in the month of December, 1899, recommenced their trials on the line from Chicago to New York, the length of which is considerably greater, being fully 1,600 kilometers. At the time of these experiments the electrical conditions of the line were particularly unfavorable, so much so that the resistance of the line, which is usually 10,000 ohms, was only 5,700 ohms, in consequence of the heavy rains. Even the Morse apparatus worked with difficulty, and a telephone indicator could only be heard feebly at the other extremity of the line; while, as for a teleponic transmission with a copper conductor, it was useless to think of such a thing, as it was impossible to hear at the other end of the line a call made in a loud voice into the microphone. Nevertheless the inventors were able to transmit telegrams at a speed which reached 60,000 words per hour. All these results demonstrated the possibility of utilizing this new system of telegraphy, and consequently MM. Pollak and Virág set themselves to adapt their apparatus to the exigencies of practice in a simple and efficacious manner. Thus, in the early apparatus used in the trials and demonstrations, the sensitized paper was displaced in a helical manner before the luminous point in a closed cylinder, and, once the message was finished, it was necessary to take the paper from the cylinder and develop and fix the characters in a dark chamber, which process was always long and complicated. The inventors, therefore, reconstructed the receiving apparatus in such a way that all these operations are automatically performed. The accompanying diagram (Fig. 3) clearly illustrates this apparatus.

A band of sensitized paper, *P*, 7 centimeters in width, is rolled in sufficient quantity in a closed box, and is displaced in a downward direction, while the luminous point moves from left to right independently of the oscillations of the mirror, in such a way that transverse lines are written on the band of paper. This is accomplished in the following manner: A small incandescent lamp, *L*, with an incandescent filament of three to four centimeters in length, serves as luminous source. This lamp is encircled by a cylindrical envelope, *C*, which can turn on its own axis, and is cut for its whole length by a slit in the form of a single turn of a screw. Through this slit there falls upon the concave mirror the luminous image of a small part of the incandescent filament which is projected on to the sensitized paper as a very luminous point. When the cylinder turns, this luminous point is displaced from right to left, the helical slit presenting a continually

* Translation of the paper read before the Congress of Electricians at Paris, in August, 1900.

changing portion of the incandescent filament to the sight. As a result, the reflected luminous point—that is to say, the real image furnished by the concave mirror—is transversely displaced on the paper band, moving from left to right, once for each rotation of the cylinder. While the luminous point is describing a line, the sensitized paper band is moved downward in such a way that at the moment the luminous point reaches anew the left position, the paper is one line lower. After being exposed to the light, the sensitized paper passes into the automatic developing apparatus. In this apparatus are two bands, *Z*, furnished with a small catch and guided by several rollers, so as to pass successively and in the proper order, the baths, *G*,

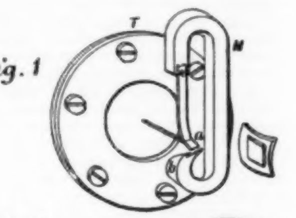
Fig. 1


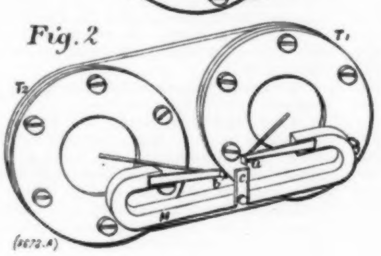
Fig. 2

(5672.A)

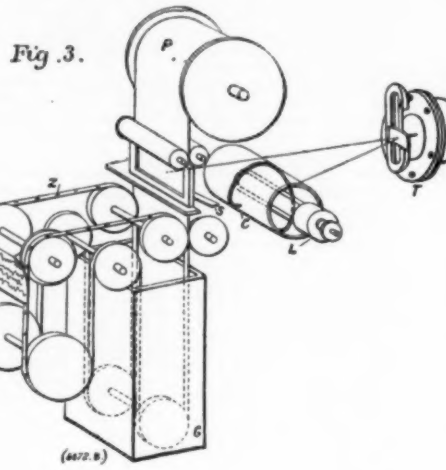
Fig. 3.

(5672.B)

Fig. 4. Fig. 5. Fig. 6. Fig. 7.

(5672.C)

necessary to develop the marks. The exposed paper band is fixed by two small rollers to the catches of the guiding bands, and passes with them through the photographic baths. After passing through the last bath, the paper is taken from the guiding bands, and leaves the apparatus as a finished photograph. A pair of scissors, *S*, fixed just below the place where the exposure takes place, is used to cut at one stroke the printed paper, and at the same time stop the non-exposed portion of the band by an attached clamping apparatus. The detached portion continues its passage through the baths, finally emerging from them in a finished state. Thanks to these convenient and very simple arrangements, the receiving apparatus is started by the sending station at the same time as the transmission of the message is commenced. The stoppage is effected at the receiving station by an employe who keeps a constant watch on the transmitted signs through a ruby glass window, and who, at the moment when the signals cease, presses upon the scissors, thus cutting the band and stopping the apparatus. This altered construction of the receiving apparatus is without doubt a most important improvement; but it is always possible to say of this system that it constitutes only a partial progress in telegraphy in view of the fact that, although it is possible to utilize a telegraph line in an entirely new manner, the system allows of no reduction of the staff employed, and does not perform with sufficient rapidity and promptitude the transmission of short messages, for it is first necessary to translate the Morse signals into readable characters.

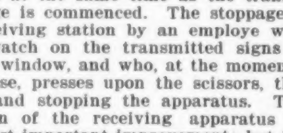
Fig. 8a. PERFORATIONS.


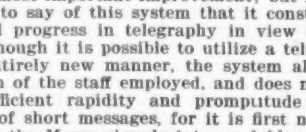
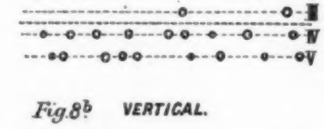
Fig. 8b. VERTICAL.


Fig. 8c. HORIZONTAL.


Fig. 8d. RESULTANT.

(5672.D)

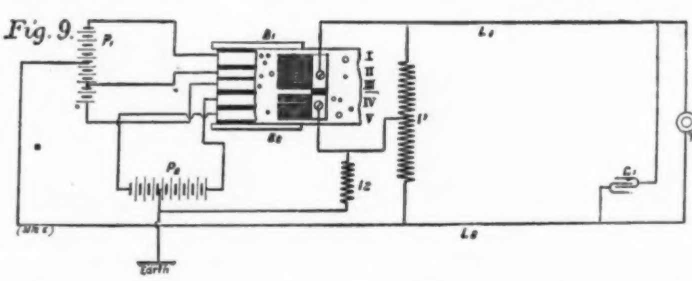
MM. Pollak and Virág therefore proposed to overcome this objection, and to send messages directly in ordinary current handwriting. Their efforts have been crowned with complete success.

By means of an ingenious combination of currents, and an interesting modification of the receiving apparatus, the inventors have succeeded, not only in transmitting messages in Morse code, but also in all kinds of ordinary handwriting. In order to accomplish this the mirror must receive from the telephone membrane impulsions of such a character that the light-ray describes not only zig-zag lines of the same height, but composite lines which will form the complete letters.

If we examine the Latin alphabet we shall see that certain letters, such as the letters *m*, *v*, *p* (Fig. 4) are formed of simple lines ascending or descending to different levels. If we decompose these letters into their elements (and by element we mean each part of the letter which can be written by a single ascending or descending movement of the pen, and which finishes at the same level as it commences) we shall see that each element of the letter can be written by the light-ray. The letter *m*, it will be seen, is composed of three elements, and the letters *v*, *p*, of two elements each. In order to write these letters by the light-ray we must be able to vary the direction, the duration and the strength of the transmitted currents. These variations would enable us to obtain corresponding movements differing in character. For this purpose we perforate the sending slip in three series, I., II., III. (Fig. 5) and the current combinations are arranged so that:

I. gives a negative current of a certain tension.
II. gives a negative current of the same tension.
III. gives a positive current of double the tension.

Fig. 5 gives an example. The size of the perforations, 1, 2, 3, is so adjusted that at the determined speed of the slip the duration of the currents is sufficient to permit of their exercising their full effect on the receiving telephone. The perforations 4 and 5 are smaller, and the duration of the contact is consequently smaller than is necessary to produce a movement in the telephone, which is as large as could be produced in it by a stationary current. Perforation 6, on the contrary, is larger, so that the contact shall last longer than is necessary merely to send a current. These perforations give the displacements 1', 2', 3', 4', 5', 6' (see Fig. 5). From these figures it will already have been gathered that by means of perforations of different dimensions, suitably arranged, we have in our possession a means of sending automatically into line currents of different characters, corresponding to the different elements of the letters, and capable of so moving the mirror as to reproduce the elements of the letters. So the letter *m* can be transmitted by three currents—that is to say, two perforations (2) and one (6), Fig. 4. For the letter, *v*, we require two currents, of equal tension and different duration—that is to say, we must employ one large perforation (6) and one smaller (5). The letter *p* necessitates two perforations (3), (6). But the Latin alphabet is composed for the most part of closed curves, that it is not possible to write with a luminous point which can be displaced only in an upward or downward direction; we must give this luminous point a horizontal movement also. For this purpose the letters are decomposed into two series of components, a vertical series and a horizontal series. Each component is written by a separate current, the interval

Fig. 9.

(5672.E)

between the currents being regulated so that the resultant of the components written by the telephone mirror represents the element of the letter in question. Suppose, for instance, we wish to write by the aid of the light-ray, the letter, *l* (Fig. 6), in which we find a closed curve if we decompose it into its elements. We commence the letter at the point 7 (Fig. 6). By means of an upward displacement, sent by the perforation (1) alone, we simply get a line like 1'; but when the light-ray arrives at 8, we send in a second current which causes a deviation from its original direction, and directs it to the left toward the point 9. Here the first perforation finishes, and consequently the first current is shut off, and the light-ray comes back to 10. At this point the third perforation commences, which by itself will produce a displacement downward like 2'; the light-ray is thus brought to 11. Here the second perforation finishes, and consequently the second current. The light-ray moves a little toward the right, forms the inferior curve of the letter *l*, and continues to the end of the third perforation; at this moment the third current ceases, and the light-ray reaches 12. The letter, *l*, is then completed.

The horizontal movements of the light-ray, of which we have been speaking, are produced by means of the membrane of a second telephone receiving currents from a separate perforation. It is so arranged that the movements of the two membranes are communicated to a single concave mirror. This small mirror which rests, in the old form of receiver, on two fixed points and one movable point, is now mounted in such a manner that of the three points one only is fixed, the other two being movable. These three points (Fig. 2) form a rectangular triangle, *a*, *b*, *c*, *a* and *b* being movable, and *c* fixed. If we move the point *a* perpendicularly to the paper, the mirror moves on the horizontal axis formed by the points, *b* and *c*, and the light-ray is displaced in a vertical direction. If, however, we move the point, *b*, the mirror moves on the vertical axis formed by the points, *a* and *c*, and the light-ray is displaced in a horizontal direction. If the two movable points are moved simultaneously, the mirror reproduces the resultant of the two components, and by this means it is possible to write all the curved lines composing the letters. The two telephones previously mentioned are combined as a single apparatus, and connected with the small mirror in such a manner that the movements of one of them, T_1, are communicated to the point *a*, and the movements of the other, T_2, are communicated to the point *b*.

In this way it is possible to telegraph every letter at an extraordinary speed. The letters are decomposed into their elements at the transmitting station and combined anew at the receiving station. Fig. 4 shows the perforations for different letters and elements, according to which these letters are combined in the receiving apparatus. To make possible the transmission of corresponding currents the paper is perforated in five series of perforations (Fig. 9). The series I., II., and III. send the currents for the telephone, T_1, which writes the vertical components and the series IV. and V. furnish the currents for the telephone, T_2, which writes the horizontal components. Two batteries with a moderate number of elements suffice as the source of the currents. The first battery, P_1, furnishes a positive and negative current of approximately the same voltage (series I. and II.) and also a positive current (series III.) of double the voltage of the preceding two. The second battery, P_2, supplies a positive current of much greater strength for the horizontal components which necessitate a movement toward the right, and a weaker negative current for those moving toward the left. The five poles of these batteries are connected to metallic disks, insulated one from another and joined so as to form a cylinder capable of turning on its own axis. Over this cylinder passes the perforated slip with its five series of perforations. A metallic brush, B_1, covers the disks furnishing the three vertical elements and a second metallic brush, B_2, covers the other two disks which furnish the horizontal components. Each of these two brushes collects the currents for its corresponding telephone, and the two membranes move the small mirror according to the resultant of the components. The light-ray reflected by the mirror is displaced with extraordinary rapidity on the sensitized paper, producing thus a tolerably clear and readable handwriting. To obtain a perfect handwriting, it is necessary to protect the vertical components from the influence of the capacity and self-induction of the line. For this purpose the same measures are adopted as in the Pollak-Virág Morse writing apparatus. A self-induction coil is inserted in parallel at the sending station, *I*. But the nature of the letters necessitates that the horizontal components be slightly retarded. For this reason when the line is only of medium length, no correcting coil is inserted in this circuit; or, if a coil is inserted, it is only of small dimension (I_2). The rapidity of the vertical displacements is represented in Fig. 7*a* and the horizontal displacements in Fig. 7*b*.

The self-vibrations are avoided as hitherto by means

of condensers. It is even possible by means of the insertion of other condensers to modify the phase differences between the vertical and horizontal components. It is not necessary, as we might be tempted to believe, to employ two pairs of conductors, one pair for each telephone. One conductor in the form of a loop is sufficient, as will be seen by reference to Fig. 9. The telephone, T_1, is inserted in the loop and for the telephone, T_2, the parallel lines form the adductor and the earth serves as return. P^1 is the battery for the vertical components. I., II., III. are the sectors which, by connection with different points of the battery, P^1, send the necessary currents into the loop, L_1, L_2, by means of the brush, B_1. In this loop is inserted the telephone, T_1, and parallel with it are inserted the condensers, C_1; this telephone moves the mirror in a vertical direction, and the induction coil, I_1, furnishes the corresponding correcting currents. The coil, I_1, is connected in its middle with the brush, B_2, which passes over the sectors IV. and V., and furnishes the current from the battery, P_2, for the horizontal components. These currents pass in parallel by the loop, and in opposite directions, through the telephone, T_1, which does not respond to them. They arrive finally at the telephone, T_2, which moves the mirror in a horizontal direction, and return by earth to the battery. The condensers, C_2, are joined in parallel with the telephone, T_2; and resistance can with advantage be inserted in this circuit. A small induction coil, I_2, is, as already stated, used when necessary to correct the second circuit.

Fig. 8*a* shows the perforations for the word "telegraf," and the vibrations executed separately by each telephone are shown in the Figs. 8*b* and 8*c*; the written word "8*d*" is the resultant of the combination of these two sets of vibrations. The perforation of the paper band is performed by a perforator, so constructed that with a single impression it is possible to produce all the perforations necessary to send a complete letter.

It is obvious that with this system there is no necessity to synchronize the receiver and the transmitter, and the working of the apparatus is thus rendered much more simple and effective. If the sensitized paper is accelerated or retarded, or if the movement of the sending slip is made faster or slower, the only result is that the writing is compressed or elongated. It is equally evident that by means of a distributer the current can be sent directly into line, which would permit the employment of some 30 sets of apparatus on a single line. Although by this method the perforations are done away with, the system with its perforated paper slip is, nevertheless, so much more economic, and offers, in my opinion, so many advantages, that ere long preference will always be given to the latter system.

The Pollak-Virág writing telegraph is not only capable of facilitating the transmission of a considerable number of messages, but it is equally capable of largely reducing the price of telegraphic communications.

Thanks to the moral and material support given to the inventors by His Excellency the Hungarian Minister of Commerce, we have been able to try this new invention on a working line. The Director-General of Posts and Telegraphs, in fact, placed at our disposal in a gracious and liberal manner four telephone lines running from Budapest to Pozsony. These four lines were joined through to the laboratory of the United Electrical Company at Budapest, and the receiver and the transmitter were inserted in the circuit in such a way that the current traversed the line in form of a loop of the length of 400 kilometers (230 miles). The resistance of the line was 2,000 ohms. The messages transmitted were written in a very correct and readable manner, and if you will permit me I will show you some of these messages which were transmitted at the speed of 60,000 words per hour.

THE WATER SUPPLY OF LAKE NICARAGUA.

A REPLY TO CRITICISMS BY THE HYDROGRAPHER OF THE NICARAGUA CANAL COMMISSION.

By ANGELO HEILPRIN, Vice-President Geographical Society of Philadelphia.

THE National Geographic Magazine for September, 1900, contains a suggestive article by Mr. Arthur P. Davis, Hydrographer of the Nicaragua Canal Commission, on "The Water Supply for the Nicaragua Canal" —suggestive by reason of the sidelight which it throws upon the measure of accuracy of the reports of the Nicaragua (Walker) Canal Commission, and its admission of the scantiness of knowledge upon which some of these reports are based. The article purports to be a refutal of the conclusions which had been reached by me regarding the instability of the surface of Lake Nicaragua, and the assertion of an abasement of level due to a shrinkage of the lake-waters (and possibly to other geological conditions)—conclusions which, as published in my latest paper, "The Shrinkage of Lake Nicaragua," are based almost entirely upon the data furnished by the Hydrographer and Chief Engineer of the Nicaragua Canal Commission and published by them as part of the official report of that Commission. Mr. Davis carefully avoids a discussion of the data which are presented in my paper, and seeks refuge under cover of a few negative generalizations, and the apologetic contention that where his data or deductions may lead into "obvious absurdity," the data should "be modified or rejected;" and we are informed (p. 364) that "up to the present time this necessity has not appeared." Whether this necessity has or has not appeared may well be left to the judgment of the reader to decide.

Mr. Davis assumed for himself the responsibility for the table of inflow into Lake Nicaragua which is used in my argument, and forms much of the basis of the report of the Chief Engineer of the Commission; and we are now told that "this table was constructed by the chief engineer upon an assumption made by me (Davis)" and that this assumption was "adopted for the want of any actual data" (p. 364). It is from this assumption that a possible escape is indicated along the channel of "obvious absurdity," the necessity for which "has not appeared." Mr. Davis' statements can hardly be taken at their full value, for if conceded, and making all allowance for the "side of conservatism" which is demanded, they would render practically valueless almost the whole of the calculated results published in the report of the Chief Engineer.

Mr. Davis attempts to impugn the value of my determination of the intake of the lake as based upon the Rivas rainfall by throwing discredit upon the Rivas record; but it is just this record which is furnished in, and form largely the basis of, his report, as well as of that of the Chief Engineer. It is also the record which appears in the official report of the earlier Nicaraguan Commission (Ludlow). It is all but inconceivable that if valueless, or if not approximating the truth, such free use should have been made of it in the calculations and deductions of the Hydrographer and Chief Engineer. Up to the present time, however, scientists have had no reason to doubt the accuracy of the record taken by Dr. Earl Flint, between the years 1880 and 1898; on the contrary, the correspondences with other observations in the later years make it practically certain that the record is fundamentally accurate.

Mr. Davis falls sharply astride of my 'third assumption" that the outflow from Lake Nicaragua has in the seventeen years from 1880 to 1896, inclusive, averaged 42 inches per annum. "This assumption," we are told, "is entirely gratuitous, apparently with no basis whatever, and, together with his table quoted from the Chief Engineer, leads Prof. Heilprin to the astounding conclusion that the lake has declined 20 feet and 9 inches in nineteen years, or 249 inches" (p. 364). I admit that the amount, 42 inches, was used for a "simple convenience of measure"—as I state it in my paper—but its basis is the 84 inches (!) which was determined by the Canal Commission as the outflow for the year 1898; and I state that the allowance is "probably fully 20 per cent less than was actually the case if the data obtained by Childs in 1850, the Nicaragua Canal Board in 1895, and the Nicaragua Canal Commission in 1898-99 be assumed as the basis for computation." If the Hydrographer of the Nicaragua Canal Commission knows that the outflow from the lake has been less than 42 inches (average), it is for him to state the fact. It would go further toward gaining confidence in the Canal scheme than the assertion (p. 365) that "as an actual fact, no one knows what was the discharge, either maximum, minimum or mean, from Lake Nicaragua prior to 1898."

Mr. Davis takes me to task for employing in "an article which purports to show conclusively that the water supply to Lake Nicaragua has very greatly declined within a generation," the very fact which in his (Davis') opinion gives "conclusive evidence that the rainfall has been greater in this region than it is at the present time," namely, that of the shrinkage of the waters. It is hardly necessary in this stage of geological science to point out that the constancy of the quantity of water in an outflowing lake-basin is not necessarily determined by nor dependent upon the rain supply of the region as a single or even primary factor. However, in quoting from Mr. C. Willard Hayes, the geologist of the Nicaragua Canal Commission, the statement that "there is no evidence whatever that the rainfall has ever been greater in this region than it is at the present time," I have only used it to fortify my requirement of "successive periods of excessive rainfall" and of rainfall "vastly in excess of what has been recorded for the past twenty years and more."

The recent issue by the United States Geological Survey of a paper, the "Hydrography of Nicaragua," by Arthur P. Davis (1900), prepared, as we are informed, subsequent to the official report submitted to the Nicaragua Canal Commission, furnishes us with some additional data bearing upon the questions of intake, outflow, and evaporation, and they fully sustain the argument that had been advanced in my paper. We not only find in this paper the Rivas record fully accepted, but confirmation of its substantial accuracy is given in the observations of rainfall (by William Climis) made at Masaya (1886-1896) and at Granada (1897), the yearly record at Masaya falling considerably below that of Rivas. Like corroboration is found in the observations, necessarily limited in time, of the Nicaragua Canal Commission (1898), made at Las Lajas, Viejo River, and Tipitapa.*

As regards the amount of evaporation from the lake, Mr. Davis has seemingly no reason to depart from his original estimate, since he reaffirms his statement that the daily evaporation is about 0.2 inch per day during the dry season. "This result (6.12 inches per month) . . . may be taken as reasonably accurate for the region of Lake Nicaragua during the dry season. In the rainy season, of course, it is less, and the region lying eastward of Lake Nicaragua having a progressively greater relative humidity also affords a smaller evaporation."†

Toward determining the discharge from the lake, a gage was placed on the San Juan River about a half-mile above the mouth of the Sabalos River, and its reading as follows is assumed to represent "essentially the outflow from Lake Nicaragua."

Monthly discharge in second-feet.

1898.	Mean.
January	18,590
February	16,633
March	14,045
April	12,169
May	11,763
June	14,144
July	19,369
August	19,552
September	22,075
October	23,430
November	25,410
December	25,050

The highest single day discharge was on December 3, 26,700 second-feet; and the lowest on May 10, 11,318 second-feet.

The above monthly discharge, calculated for the entire year, from a surface of 2,975 square miles (that of Lake Nicaragua), would lower that surface by almost exactly 7 feet, or 84 inches, the amount that is actually assumed in the report of the Chief Engineer of the Nicaragua Canal Commission. It is the half of this amount, or 42 inches, that I have assumed in my paper as a theoretical average of annual discharge, and to which Mr. Davis objects as being "entirely gratuitous, apparently with no basis whatever." It so happens, however, that this amount is actually proportionably *less* than the *lowest* discharge that is furnished by the tables of Mr. Davis, that of May 10, 11,318 second-feet; so that if I am in error at all, it is in assuming a too low, rather than a too high, discharge. My figure, moreover, corresponds, I believe, to the very lowest discharge that has *ever* been noted for the lake, namely, 9,420 feet per second, reported by the Nicaragua Canal Board, from a gaging made at Fort San Carlos, on May 27, 1895, the lake then standing at the exceedingly low level of 101.07 feet.* It is interesting to note in this connection that the Nicaragua Canal Board of 1895 assumed, with very meager data before them, the annual discharge from the lake to be 696,960,000,000 cubic feet, a volume that would have lowered the lake by somewhat more than 8 feet. Applying to this the rate of evaporation that is furnished by Mr. Davis, 60 inches, we should then have a total loss to lake of 156 inches, as against almost exactly the same amount of intake (155 inches) computed for very nearly the wettest year that has been recorded in the lake region (1898: rainfall, 108 inches at Rivas).† The relation of this sustained balance to an average, and more particularly to a dry, year—when the outflow, proportional to the intake, is only partially arrested, and the evaporation not at all—speaks for itself.

The facts before us, with others furnished by the surveys of Childs and Lull, permit us, then, to assume:

A minimum annual discharge from the lake of 42 inches.

Evaporation (approx.) 55 inches.

Intake for the lake, as calculated by the Engineer and Hydrographer of the Nicaragua Canal Commission upon a rainfall of 65 inches at Rivas, 85 inches.‡

A net loss to the lake of 12 inches.

Manifestly, then, the data furnished by the Hydrographer of the Nicaragua Canal Commission are entirely erroneous, or they lead incontestably to the conclusion that Lake Nicaragua is undergoing a steady and progressive abasement of its surface level.

* Twentieth Annual Report, U. S. Geol. Survey, 1900, pp. 574-578.

† Op. cit., p. 582.

* Report Nicaragua Canal Board, 1895, p. 132.

† The Nicaragua (Ludlow) Canal Board properly asserts that their figures "may all be considerably in error," and emphasizes the almost total lack of knowledge that is necessary for the intelligent consideration of the control of the lake's discharge. "The amount of water to be dealt with, either during the year or during high floods, is unknown. The annual rainfall is not known at any point between Ochoa and the west shore of the lake." Report, 1895, p. 29.

‡ The intake for 60 inches rainfall is placed at 78 inches; for 70 inches rainfall at 93 inches. I have assumed the mean of these two amounts for 65 inches. Mr. Davis, in his latest report, states that the mean rainfall so far observed at Rivas is "under 70 inches" (Twentieth Annual Report, U. S. Geol. Survey, 1900, p. 575).

ELECTRIC EARTH CLOCK.

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

MY attention has been called to certain errors in detail in the description of the "Electric Earth Clock," which I take this opportunity to correct. In the second column, paragraph 3, the text reads: "The hardened steel knife edge is also shown in the center resting on its tempered steel support, *Q*." By this is meant horizontally, not vertically; in other words, it could have read between the ends of the little rods.

Regarding the diameter of the pendulum tubes for the reception of the mercury, would say that it does not matter whether the internal or the external diameter is taken, as the weight of a pendulum bob is never a factor. The height of the steel block supporting the knife edge should be ½ inch instead of ¾ as illustrated, and the brass spools should measure $1\frac{5}{8}$ inches between rings instead of $1\frac{3}{8}$ inches as printed.

N. MONROE HOPKINS.

December 31, 1900.

ENAMELINE PRINTING—THE METAL.

By W. T. M. DAVIDSON.

HALF-TONE blocks are generally made on either zinc, copper, or brass. According to what is required of the block, so the metal must be selected. If the run from the block is to be a short one—that is, anything from ten to fifteen thousand copies—zinc will answer admirably. If the run is a fairly long one, or if electros are to be taken from the original, copper should be used. Theoretically, the best work is done on copper, and taking everything into consideration it is the best; for if etched properly it is superior for electrotyping.

For a special long run from the original block, brass is sometimes used. Owing to the enamel not standing during the whole time of etching this is a very unsatisfactory metal and is rarely used for that reason. Personally, if I was making a block to withstand the maximum run, I would sooner do it by the albumen method on zinc than the enameline on brass.

While on the subject it may perhaps be of interest to point out the running capacity of the different metals after passing through the various processes.

(1) Zinc......	Enameline	process.	Short run.
(2) Copper.....	"	"	Medium run.
(3) Brass.....	"	"	Long run.
(4) Zinc......	Albumen	"	Long run.

The reason that zinc, when used for the enamel process, has such a short life is that the metal becomes disintegrated by the high temperature at which it has to be burnt in to transform the glue image into enamel. Copper gives a fairly good run, because the metal is not affected by the heat, but being a softer metal than either brass or zinc, it cannot outstay these metals on the printing machine.

What is known as "14 or 16 gage" metal is mostly used. For copper and brass, if cost is considered, 16 gage will do; but for zinc nothing thinner than 14 should be used.

Either a straight or round polished surface is the condition in which it is placed on the market. Round polished is a little more expensive, and as in most cases it is all destroyed in the final cleaning I do not see the advantage of it.

There are various ways of cutting the metal up. A

circular saw or a guillotine is the best, but for a cheap and effective tool an ordinary hand saw answers well.

When a guillotine is used there is no burr thrown up, but after cutting by a saw the burr must be removed with a file.

The cleaning of metal is performed by rubbing with a damp rag or felt pad which is dipped in fine pumice powder. The motion must be straight up and down. No crossing is permissible, as the slight scratches caused by the pumice show immediately. A good quality charcoal is greatly used, and, given a fair sample, there is nothing to beat it; but with the commoner sort the metal is always getting deep scratches, which render it useless for half-tone work. If charcoal is being used it should always be kept in a basin of water on the cleaning bench. Rouge powder, rotten stone, whiting, or any other powder for cleaning metal will do. With these finer powders, if desired, a circular polish can be given, but it will not affect the resut.

When all trace of dirt and grease has been removed from the metal it must be rinsed immediately under the tap. If any of the cleaning powder is allowed to dry on the surface, the metal will be spoiled, as an etching action takes place which leaves marks.

If the water remains evenly all over the plate, that is, does not run off as from a duck's back, the cleaning is complete. Importance should be attached to this, as it is very often the cause of enamel leaving the plate. See that the back is free from grit, otherwise the plate, when being whirled, will come off owing to the pneumatic holder not having absolute contact.

Now take the whirler in the left hand and the plate in the right, press in the pneumatic holder of the whirler with the thumb and adjust to the back of the plate, care being taken to see it is central. Release the thumb and the plate will be firmly held.

If it is a very large plate perhaps some difficulty will be encountered in fixing the exact center. This must be found, for with a plate this size the slightest deviation will cause it to be thrown off when rapidly whirled. On the back of the plate draw a line from opposite corners, passing through the center, and adjust the whirler where the lines cross.

Before proceeding, a word or two here on whirlers. Practically, there is only one form of whirler used now. In form it is nothing more or less than the common drill with a pneumatic holder in place of the drill. The speed at which it whirls is not a matter of importance; but if more than one whirler be in use, and the same glue is used with each whirler, then the speed of the whirlers must be uniform, otherwise on certain whirlers the glue will be either too thick or too thin. Adhere to whatever speed of whirling you get accustomed to. I always advise whirling to be done as fast as possible. Knowing your speed you make up your glue to suit it. If when whirling at your top speed, the fish glue gives a nice strong enamel suitable for printing a dry plate, the same glue whirled slowly on a whirler geared lower, would come off the plate after printing.

A final filtering of the glue solution must be given immediately before use. Select a funnel with a long neck—one that reaches almost to the bottom of the vessel which is to hold the filtered glue. If the solution is allowed to drop from any height, bubbles are formed and the filtering will have to be done all over again. Place the cotton-wool lightly in the neck of the funnel and refilter the first half ounce of glue, as it carries a certain amount of fluff from the wool. A perfectly clean vessel, the same shape as the one holding the funnel, should be placed by its side.

Now to get back to the coating of the metal, which is a simple operation, but requires to be done carefully and rapidly.

In placing the plate on the whirler care must be taken that the palm of the hand holding the metal is not greasy. Always have the hand as moist as the plate; if this is not sufficient use a damp rag between the palm and the plate. Now rinse plate well under the tap and pass a piece of cotton-wool over the surface and edges. Give final rinse, hold whirler in left hand, and allow to drain off. With right hand remove funnel to empty vessel and pour a pool of glue on the plate at the top right hand corner. Now incline plate so that the glue runs all round, and pour off excess into funnel. Repeat this operation, as the first glue may be thinned a little by the water on the surface of the plate. When the second lot has drained off, replace funnel in original vessel to go on filtering. Turn the plate face down in the sink and whirl as fast as possible. Having whirled for about five to ten seconds turn plate face up and by gently pressing pneumatic holder, release it. Hold plate face up over a gas flame, turning from corner to corner to make it evenly hot. Make it just about hot enough to hold, care being taken that the edges are dry, and place face against a wall to cool. Once having got the glue solution clean by filtering there is no trouble in coating and getting perfectly clean plates, but the essential thing is smartness. It must be remembered that the more the operation is prolonged the greater the chances of dust settling from the atmosphere. As some idea of the speed at which the operation must be performed, let me say that from the time of the final rinse to the completion of the drying not more than twenty-five to thirty seconds should elapse. Some printers dry the plate by whirling face down over a gas stove, maintaining that by so doing the dust is avoided. If this method is worked great care must be taken that the glue is not scorched; in fact, a sheet of iron should be placed between the flame and the coated plate. The idea, I believe, is quite a fallacy, as the extra time taken in drying allows more opportunities of dust settling, and the current of hot air rising is calculated to carry fine matter which finds an ultimate resting place on the film.

This operation of coating need not be performed in a dark room. The glue in its liquid state is practically insensitive; it only becomes sensitive to light when in the form of a thin dry film. Even then a powerful light is required if the exposure is to be done in from ten to twenty minutes. Consequently, if the light in the room is subdued at all, it is perfectly safe for coating the plate.

Now prepare the printing frame for the reception of the negative and metal. First of all see that the thick plate-glass of the frame is clean, both sides. Well dust the frame to free it from grit and other matter, for the slightest thing to make the pressure uneven between the plate-glass and the rabbet of the frame will be the cause of smashing the glass on screwing up to obtain contact between the metal and the negative. Having cleaned the glass side of negative, warm it to make it same temperature as the plate (both should be slightly warm), otherwise they may possibly stick together. Now lower negative gently on to the metal, film to film; when adjusted centrally turn completely over and lower into the frame. Place a stout felt pad on the back of the metal and then the wooden back of the frame on that. Screw down now from opposite corners, first light pressure on one pair, then on the corresponding opposite screws, until they are both up tight. If full pressure is put on one pair of screws right off, the glass will probably break when the others come to be tightened.

The frame is now ready for exposing and should be placed at the fixed distance from the arc or with an actinometer if the exposure is made to daylight. It is best, if exposure is being made at an arc, to turn the frame over, half way through the period, in order to avoid the shadows sometimes thrown by imperfections in the glass.—The Process Photogram.

GERMAN BEET-SUGAR INDUSTRY.

THE fiftieth annual convention of manufacturers and others interested in the German sugar industry was held at Magdeburg on May 29 to June 1, 1900. In connection with this convention there was an interesting exposition of sugar machinery, etc., showing all recent improvements and inventions. Five hundred and ten members of the Sugar Union were present, representing one hundred and seventy-three factories. Some of the most interesting matters discussed were the following:

THE SACCHARINE QUESTION.

The imperial law regulating trade in artificial sweet stuffs, which was intended to restrict the sale of saccharine, has had an entirely contrary effect; for, according to the statements of saccharine manufacturers, the saccharine produced last year was equivalent in sweetness to over 1,000,000 centners (50,000 metric tons) of sugar. Consequently, the consumption of 1,000,000 centners of sugar was prevented, causing a loss to the imperial treasury of 10,000,000 marks ($2,-380,000). The imposing of a tax on saccharine and the requirement by law that it be sold only as a drug are accordingly demanded with justice by the sugar industry. Unfortunately, this question can not be brought up for settlement prior to the next meeting of the Reichstag.

DANGER TO THE SUGAR INDUSTRY FROM SACCHARINE, ETC.

The discovery of saccharine and other sweet stuffs has caused some sugar producers much anxiety, and it is feared that still other similar substances will in the future be discovered by chemists. Furthermore, some farmers are afraid that a method will eventually be found by which beet sugar can be produced synthetically. Neither of these dangers need, however, be feared at present. It is entirely unlikely that it will ever be possible to produce from pit-coal tar genuine sugar in large enough quantities and sufficiently cheaply to seriously injure the beet-sugar industry. Farmers may also find comfort in knowing that, while it is not impossible (in view of the rapid advances now being made in chemical knowledge) that a process may be found for producing genuine beet sugar artificially, it is nevertheless certain that when the synthesis of sugar is discovered, carbon hydrates will be needed as material, especially in the form of starch flour. Accordingly, even if a sufficiently cheap process be found, the only result will be that other plants containing starch—the potato, for instance—will compete with beets as a raw material in sugar fabrication.

EMPLOYMENT OF ALIEN LABORERS.

Another matter which is considered very important is that Polish laborers who enter Germany every spring should not be compelled to leave the country before a fixed date, which should be the same in all parts of the Empire. Farm hands are so scarce that difficulty is experienced in raising enough sugar beets to supply the demands of the factories. As imported Polish laborers are now compelled to leave Prussia by December 1, the three hundred and eleven Prussian sugar factories are put at a disadvantage as compared with the ninety-one factories in the other German states where there is no such requirement. The Government has accordingly been asked to establish a general rule permitting such useful aliens to remain in the country each year until the end of December.

THE NEW SUGAR CARTEL.

Speeches were made explaining that this cartel is intended for the protection of the German sugar industry as a whole and for the general benefit of all producers.

CONDITION AND DEVELOPMENT OF THE CUBAN SUGAR INDUSTRY.

An interesting report on the subject was read by Governmental Privy Councilor Prof. Dr. Paasche, member of the Reichstag, who has recently studied conditions in Cuba. Dr. Paasche took the ground that the German sugar industry is a world industry in the strictest sense of the term, and that its welfare is therefore dependent upon the maintenance of the position which it now holds in the world's markets. All measures adopted for the purpose of influencing the home market, no matter how important they may be, will not, therefore, alone suffice to keep the industry in a healthy condition. German sugar producers must continue to keep their eyes fixed on all competing lands. Dr. Paasche's visit to the United States and Cuba was solely for the purpose of ascertaining if dangers threaten the German sugar industry there. The following is a summary of his remarks:

"Formerly, Cuba was the foremost sugar-producing land of the world and controlled the world's markets. Before the recent war, it produced annually over 1,000,-000 tons. This amount was reduced 25 per cent. by the war, and the shortage was promptly filled by lands other than Germany. Russia, Austria, Java, etc., have largely increased their production. If Cuba regains its former productiveness, or, still worse, if it doubles its production, as some fear, the magnitude of the disaster which will result in the world's markets can not be overestimated. Fortunately, however, there is no immediate danger. The predictions concerning the moderate amount of this year's crop have been realized. Furthermore, there is little cause for fear in the near future. The results of the war in Cuba are frightful. For miles the traveler passes through desolated country where houses and huts lie in ruins. Many factories have been destroyed, and the walls and broken machinery are overgrown with tropical vines. Where there were formerly broad fields of sugar cane, there are now to be seen only weeds and rank vegetation. Laborers are scarce because many thousands of them starved or were murdered during the war. Capital and enterprise are also lacking, and without these factories can not be rebuilt and operated. In order to give new life to the industry, enormous capital will be needed, for business must be transacted on a very large scale if the industry is to be made profitable. At the same time, it must be admitted that hardly anywhere else in the Tropics are the conditions naturally so favorable for the sugar industry as in Cuba. The soil is fertile, and the geographical position of the island is most suitable for commerce. The factories are large and well equipped with labor-saving machinery. Good, but not too cheap, raw materials are available, and the manufacturing process in use is effective and inexpensive. But, as has been said above, capital and enterprising spirit are needed. Even the Americans are afraid to invest money in this at present unsafe business, and therefore the manufacturers are obliged to pay a very high rate of interest on their debts. Most of them are in debt, as even those who did not suffer from fire during the war lost heavily in other ways. Everything now depends upon the course which the political development of Cuba will take."

Dr. Paasche thinks that if Cuba were annexed to the United States, and the Cuban sugar industry enjoyed the advantages of the American customs tariff, thereby securing increased prices, American capital might be attracted by the increased profits of the business. "The only thing for the German sugar industry to do," he adds, "is to face these dangers with united forces, continuing its present policy. Thus, in spite of whatever may happen, Germany will be able to maintain the foremost place which it has now gained."

EXPORT REPORTS.

Another question considered by the conference was, Is it advisable from time to time to send an expert to the various sugar-producing countries to prepare reports in regard to crop prospects and existing conditions? This question was practically decided in the affirmative, though it was thought best to do this only occasionally and when there is some special reason for such action.

APPOINTMENT OF AN EXPERT TO CONTROL APPLICATIONS FOR PATENTS.

This question has been under consideration since 1893. The sugar industry needs protection against inventions which are not really inventions, and also against patents which are not distinctly worded. An expert chosen for this position would have to decide in each case whether it is in the interest of the sugar industry to raise objection to the granting of a patent. Such an expert must have a scientific and technical education, and also experience in all branches of the industry. Some retired factory director will probably be able to fill the position best. It is held that before any alleged improvement affecting the sugar industry is admitted to be a patentable invention, an expert representative of the industry should be given an opportunity to examine it and decide upon its worth and utility.

INFLUENCE OF CHEMISTRY ON THE DEVELOPMENT OF THE INDUSTRY.

The influence which chemistry has exerted upon the production of beet sugar has been very great and has rendered possible the victory of the beet over sugar cane, the production of beet sugar in the world being now twice as large as that of cane sugar. No other existing industry is subjected to such thorough and scientific control as is the German beet-sugar industry. In German sugar factories there are now employed about one thousand chemists who give their undivided attention to furthering the interests of the industry. This trained personnel is of the greatest importance.

UTILIZATION OF WASTE MATERIALS IN THE MANUFACTURE OF BY-PRODUCTS.

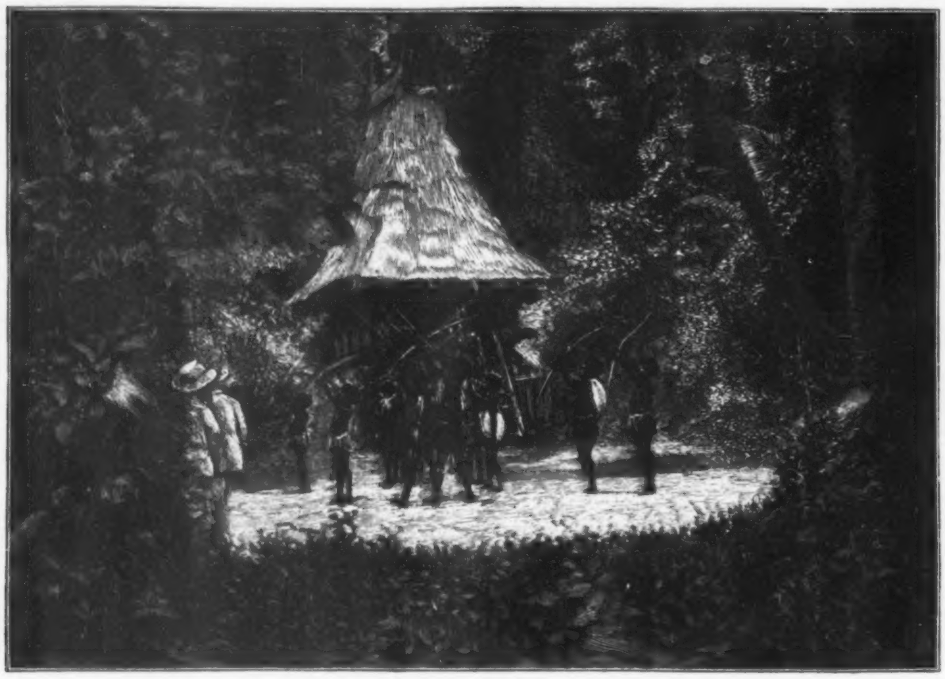
The production of sugar from molasses has been of great importance to the industry, and it first led to the employment of chemists. The utilization of waste materials in the manufacture of by-products has also had a beneficial effect. By cooking molasses dregs, after the removal of the sugar, a potash is won which is preferred to all other sorts in the soap industry. From the parts of the same material which contain nitrogen, cyanide of potassium is also produced. This substance is much used in modern gold mining in the Transvaal, and also to a growing extent in the United States. It is believed that a method will be found sooner or later for using electricity in the clarification of beet juice.

INCREASE OF THE PERCENTAGE OF SUGAR IN BEETS.

The scientific cultivation of beets for the purpose of securing improved seed dates back to 1850, when individual beets found to be especially rich in sugar were first selected for this purpose. This plan has been carefully adhered to ever since, the best results being obtained at Klein Wanzleben, near Magdeburg. German beet-seed raisers have thus succeeded in distancing all their foreign competitors. Fifty years ago, beets containing 10 to 12 per cent. of sugar were considered good; but now an average of 14 to 16 per cent. is not uncommon, and in exceptional cases still better results are reached. In the meanwhile, the percentage of sugar in sugar cane has remained unchanged, namely, about 12 per cent. in medium qualities.—George H. Murphy, Vice-Consul at Magdeburg.

THE GERMAN COLONY OF NEW GUINEA.

FIFTEEN years have passed, says a writer in the Illustrirte Zeitung, since New Guinea, the Dark Continent of the South Sea, was divided. Of the three Powers concerned in the partition—England, Holland, and Germany—the third was the last to come to this great colonial dominion. And, no doubt, it is of interest to learn what the Germans have accomplished during the fifteen years of their sovereignty.



NATIVES OF SELEO PRACTISING AT ARCHERY.

From the Moluccas our steamer sailed, for several days, along the steep and woody coast of New Guinea, so closely at times that we could have seen a village or even human beings. But nowhere was there a sign or trace of either—only continuous dense and dark forest; forest from the foaming beach up to the crest of the coast hills, and forest beyond to the distant mountain chains. The western part of the island, which for centuries past has belonged to Holland, is one and one-half times as large as the German Empire. The Hollanders have never attempted to colonize this vast territory; even to-day not a single white man is living there. From the boundary of the German territory we still had eighty knots to cover before we reached the wide and deep bay designated on the maps by the much-promising name of Berlinhafen. Off the coast here, several miles distant, lie the two islands, Seleo and Tamara. It is on these islands, having an area of many thousand square miles, that the only whites, seven in number, reside. Of their dwellings nothing as yet could be seen. Our steamer cast anchor about a mile from shore, and soon we were surrounded by numerous Papuans in their canoes, offering us all kinds of tropical fruits, bows, arrows, clubs, etc., in exchange for a little tobacco, glass beads, pieces of old iron, and rags. But, more than their ethnological treasures, the natives themselves absorbed our interest. Such singular and grotesque beings I never met in my many travels. Nigh stark naked, their enormous curly heads besmeared yellow, green, or white, their faces gaudily painted, the upper part of their bodies colored red or blue, they seem like veritable devils, in comparison with whom the most savage Indians might well be called civilized. These were the neighbors of the German Catholic missionaries of the "Order of the Divine Word," who for the past four years have chosen the island of Tamara as a field for their religious work. They were the first settlers in this territory. Amid the hostile savages, they built their simple hut, their modest little chapel, thus becoming the pioneers of the trader and the planter, and it was due to their labors that one year later a trading-station of the New Guinea Company could be opened on the opposite island of Seleo, without molestation from the natives.

In Tamara, as well as in Seleo, we had opportunities for becoming acquainted with the natives in their villages. Upon rough-hewn piles driven in the sandy soil, beneath the shade of tall cocoa-palms, they have built their modest huts, mere thatched roofs or coverings, beneath which they store their few household utensils, such as stone knives and hatchets, clay pottery, wooden bowls, and shell spoons. While the women work, the men practise with bow and arrow, and with the spear, with both of wihch weapons they are remarkably skillful. At our request they brought down with their arrows every high cocoanut pointed out to them with infallible accuracy. With equal skill they spear every fish. Having caught a number of fish, the men proceed to the fantastic Tamboran houses (devils' houses) and prepare a great feast. In these tower-like straw structures, adorned with grotesque fetishes, the natives collect the skulls of their dead, whom they bury near their huts, and sometimes in them. Thanks to the influence of the missionaries, many of the savages are already employed on the pretty plantations laid out on the island of Seleo by the representative of the New Guinea Company. Numerous sailing vessels of this company engage in barter between this station and the coast towns, as well as with Gilbert, Schouten, Matty and Admiralty Islands. The natives of these isles are, however, not half as pacific as those of New Guinea.

About 200 knots distant from Berlinhafen lies Potsdamhafen, where, as in the former colony, there are a trading-station of the New Guinea Company and a Catholic mission. The most important settlements of the New Guinea Company are, however, in Friedrich-Wilhelmshafen and Stephansort.

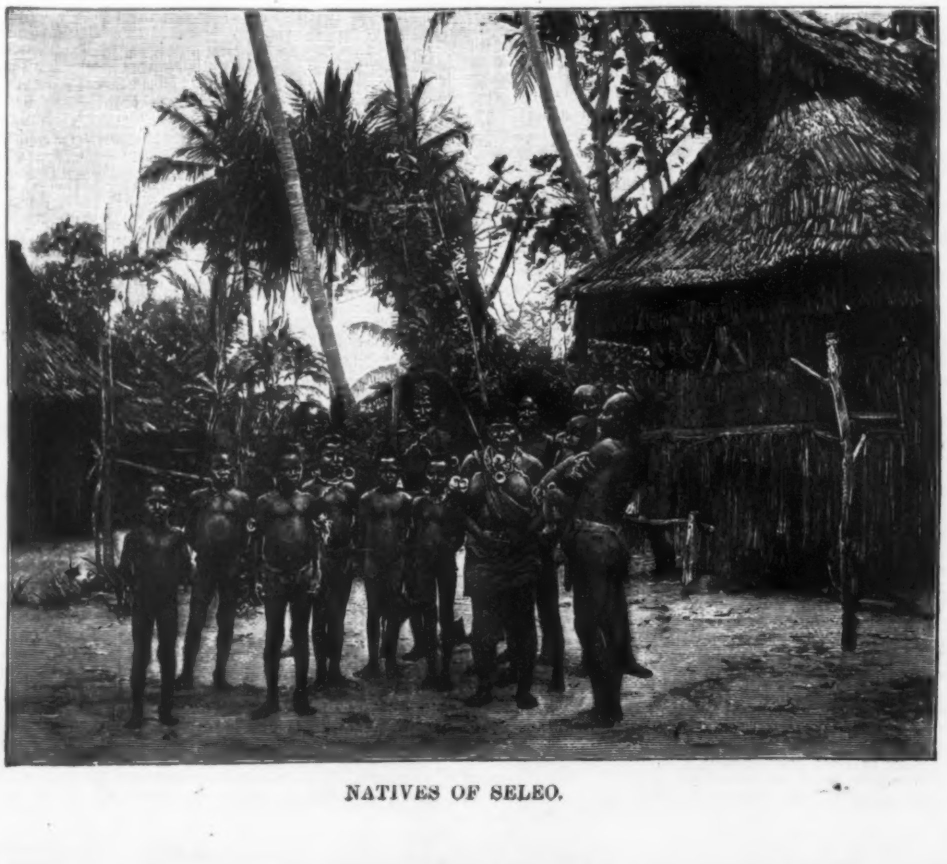
Were the fever-breeding climate of New Guinea not so deadly, a more delightful and charming dwelling place in the tropics could not be imagined than picturesque Friedrich-Wilhelmshafen, with its great island-dotted bay, along whose shores the vast cocoanut, coffee, tobacco, and caoutchouc plantations of the New Guinea Company extend for miles. The company has spent millions on the plantations, the harbor, docks, warehouses, and laborers' barracks. And, as the seat of the Imperial German Government for New Guinea is also located here, this small settlement makes quite an imposing impression. There is no doubt that, to-day, Friedrich-Wilhelmshafen, with its twenty white inhabitants, consisting exclusively of men, is the largest settlement of whites in New Guinea. In British New Guinea the conditions are by far not so encouraging. The largest plantations (comprising an area of fourteen square miles) owned by the New Guinea Company are in Stephansort, situated a distance of only seventeen miles from Friedrich-Wilhemshafen; but as yet there is no overland route between these two colonies. In Stephansort there is a German Club, a bowling alley, post office, hospital, and even a railway, the motive power of which is furnished by a yoke of oxen instead of by locomotives. Tradesmen, however, such as shoemakers and tailors, locksmiths, and carpenters, glaziers and bakers, are conspicuously absent; and, although life under the newly instituted Imperial German Government has become much safer and more orderly, nevertheless years will elapse before the number of planters will increase to such an extent as to make the trades-people indispensable.

Considering the extraordinary fertility of the soil, the cheapness of land, and the moderate cost of living, it can be assumed that New Guinea will soon attract a large number of planters. The rich gold deposits discovered on the upper course of the Ramu River will also entice many whites to German New Guinea, thus paving the way for mechanics and tradesmen in general.

With the liveliest interest I journeyed through the several colonies and studied the life on their vast plantations—those plantations which were created by dint of toilful hewing down of trees in the native forest, and which are now worked by Chinese, Malays, and laborers recruited from Neupommern and Neumecklenburg. These laborers have paved the way for the inhabitants of the native Papuan villages, and have shown them how, with the aid of the mission schools (the only schools in New Guinea) they may outgrow their wild and grotesque primitiveness.

Although Finschhafen was the first German settlement in New Guinea, it had to be abandoned on account of the deadly climate, and where once stood many buildings, workhouses, and cottages, a new tropical jungle has grown up. We next visited the enterprising village of Simbang, in the territory of the Neudettelsauer Mission, which has laid out large plantations on the near-by Sattelberg. Here in the straits between New Guinea and Neupommern there is not inconsiderable trade among the natives. On various islands the Papuans engage in various industries, such as pottery, wood-carving, and canoe building, and at

A SELEO FAMILY.



NATIVES OF SELEO.

certain times they bring these goods to a common market, a circumstance which promises further development.

THE INTERNATIONAL CONGRESSES OF METEOROLOGY AND AERONAUTICS AT PARIS.

THESE Congresses were held nearly simultaneously on account of their allied interests. The Meteorological Congress, which began its sessions on September 10, had the same character as the Congress held during the Paris Exposition of 1889, that is to say, it was open to all meteorologists; and although the countries participating in the Exposition were invited to send delegates, yet these had no power to pledge their respective countries to any action. More than thirty countries were represented this year at the Congress, and about one hundred persons of various nationalities attended its sittings, which, consequently, were more truly international than was the case with any preceding Congress. The absence of the Chief of the United States Weather Bureau was much regretted, and the United States was represented solely by the officials in charge of the Weather Bureau exhibit at the Exposition and by the writer, who had also been the delegate of the United States in 1889. The place of meeting was again at the rooms of the Societe d'Encouragement, outside the Exposition grounds.

M. Mascart, the director of the French Meteorological Office, was chosen president of the Congress, which he directed with his usual ability, being ably seconded by M. Angot as general secretary. Three vice presidents represented England, Russia and Norway, respectively. At least half of the hundred papers presented were discussed by five standing committees, whose sittings were open to any persons interested in the subjects. The most important work of the Congress was performed by these committees, foremost among them being the Aeronautical Commission, presided over by Professor Hergesell, that discussed the results obtained in the exploration of the atmosphere by the international use of balloons and kites, and the improvements that could be effected in instruments and methods. Professor Violle, as president of the Commission on Solar Radiation, summed up the state of the subject and heard several papers. Professor Rucker left the meeting of the British Association to preside over the Commission on Terrestrial Magnetism, which had presented to it the work being done by magnetic observatories and surveys throughout the world. The Cloud Commission, the oldest of these committees, has always had at its head the indefatigable Professor Hildebrandsson, who was now able to summarize the results of the cloud measurements that through his efforts had been executed in various parts of the world during the so-called "international cloud-year." It was resolved to invite the meteorological observatories to undertake special observations of clouds each month on the days that the international ascents of balloons and kites were made in Europe. Eminently practical was the Commission for Weather Telegraphy, which proposed to accelerate the weather dispatches in Europe by introducing the "circuit system" of the United States, but found it necessary to refer the matter to the International Telegraphic Bureau at Berne. From the scope of these committees it will be seen that comparatively few subjects were left for discussion in the general sessions, which, consequently, had less interest than usual and served mainly to confirm the resolutions of the commissions.

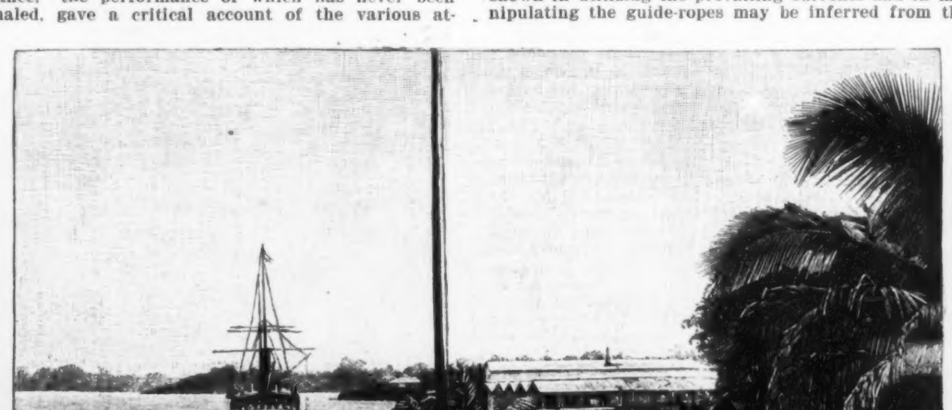
Among the institutions visited, the most interesting was the observatory for dynamic meteorology at Trappes, near Versailles, where M. Teisserenc de Bort maintains an admirably equipped observatory, especially engaged at the present time in investigations of the upper atmosphere. This observatory, designed in general after that at Blue Hill, possesses, besides, means of obtaining temperature data at very high altitudes by the "ballons-sondes" which are sent up twice a week and carry self-recording instruments to the height of ten miles or more. Owing to the many distractions of Paris, the only general entertainment was the banquet on the Eiffel Tower, and this was notable for the eloquent discourse of M. Leygues, Minister of Public Instruction, who welcomed the meteorologists assembled from all parts of the globe as engaged in a science that benefits humanity and is independent of nationality. Co-incident with the Congress, the International Meteorological Committee held a meeting and filled the vacancies existing in it, caused by the retirement of Dr. Scott, of England, and Professor Tacchini, of Italy, by electing to membership Dr. Shaw and Professor Palazzo, their successors as heads of the meteorological bureaus in their respective countries. Professor Hildebrandsson becomes secretary of the committee, a position long and faithfully filled by Dr. Scott.

The Aeronautical Congress convened on September 17, the day that the Meteorological Congress adjourned. The general sessions were held at the Astro-physical Observatory at Meudon, but the sections met at the Institute of France, in Paris. The committee on organization continued in office, namely M. Janssen as president, and M. Triboulet as general secretary. Among the honorary vice presidents was Professor Langley, who, with the writer, was a delegate of the United States. No other Americans attended the meeting, and the difficulty of getting to Meudon, no doubt, was one reason why so few persons came of the one hundred and fifty enrolled. M. Janssen's address was a masterly *resume* of the progress of aeronautics since the Congress of 1889, and contained appreciative mention of the exploration of the atmosphere by balloons and kites. In speaking of the future, M. Janssen predicted that the nation which first learned to navigate the air would become supreme, for while the ocean, which has given pre-eminence to the people using it most, has its boundaries, the atmosphere has none. What then, asked the illustrious orator, will become of national frontiers when the aerial fleets can cross them with impunity? Two important conferences were given by the Renard brothers, the well-known officers in charge of the Central Establishment for Military Aeronautics at Chalais-Meudon. Major Paul Renard described the present state of aeronautics as exemplified at the Exposition. Colonel Charles Renard, who, with Major Krebs as collaborator, constructed at Chalais in 1884 the dirigible balloon named "La France," the performance of which has never been equaled, gave a critical account of the various attempts to navigate the air by such balloon methods, terminating with the balloons recently constructed by M. Santos-Dumont in Paris, and the huge one of Count von Zeppelin on the Lake of Constance. The other lectures were by M. Teisserenc de Bort on the meteorological results at Trappes from "ballons-sondes" and kites, and by the writer on the use of kites at Blue Hill to bring down such data from altitudes of three miles. In Paris special and technical papers were presented to four sections relating to different branches of aeronautics, and at the closing general session these communications were summarized and some resolutions were adopted. An international aeronautical committee was appointed, consisting, besides the officers of the Congress, of ten Frenchmen and ten foreigners, whose duty it is to advance aeronautical work throughout the world. On September 21 a delightful banquet at the Orangerie of the Chateau of Meudon, where the first balloons were constructed during the Empire, closed the Congress, and predictions were freely made that the conquest of the air was near at hand, and that possibly members might come to the next reunion in aerial conveyances.

The noteworthy feature of this meeting, which could hardly be called international, was the demonstration of the practical status of aeronautics in France. Through the courtesy of the Minister of War, the establishment of Chalais was opened to the public for the first time, permitting the construction and manipulation of the war balloons to be seen, and what was more interesting to the student, the apparatus employed by Colonel Renard in determining the resistance of the air to various bodies moving through it. At the Park of Vincennes, in connection with the aeronautical section of the Exposition and through the co-operation of the Aero Club, balloon races were organized, and each Sunday the novel spectacle was presented of a great number of balloons starting on their journey without delay or difficulty. On one afternoon seventeen balloons rose successively, each aeronaut endeavoring to land as near as possible to some point that he had fixed beforehand. The skill shown in utilizing the prevailing currents and in manipulating the guide-ropes may be inferred from the

A PAPUAN CANOEING PARTY.

PAPUAN LABORERS IN FRIEDRICH-WILHELMSHAFEN.



VIEW OF FRIEDRICH-WILHELMSHAFEN.

fact that one aeronaut, after a voyage of thirty miles, landed with.n half a mile of his goal. The same evening eight more balloons ascended, and on the following Sundays there were competitions for height and distance. In the former contest a balloon, filled with 106,000 cubic feet of illuminating gas and carrying a single aeronaut, rose more than 27,000 feet, a height never before attained in France, unless perhaps by the ill-fated "Zenith," when two of its passengers were asphyxiated. In the final long-distance race, about 1,400 miles were traversed in thirty-seven hours, and three of the six balloons landed in Russia. All these voyages, accomplished without accident, tend to popularize ballooning as a sport and to facilitate its practical employment whenever the dirigible balloon shall be realized. As before mentioned, a very interesting attempt to solve this problem is being made at Saint Cloud, near Paris, by M. Santos-Dumont, who sits beneath a cigar-shaped balloon and controls a gasoline engine driving the propeller placed in front. In the trial witnessed of his balloon No. 4 an accident to the rudder made it necessary to hold the balloon captive, but, nevertheless, it advanced into a light wind and was easily managed. This balloon will compete for the Deutsch prize of $20,000 for a voyage to the Eiffel Tower and back, a distan e of seven miles, in half an hour. The aeronautical exhibit in the Champ de Mars was chiefly restrospective, but a novelty was the "Avion," or flying machine, of M. Ader, which resembles a gigantic bat; and although it has never been tried in the open air, yet the ingenious construction of the supporting surfaces and the extreme lightness of the steam-engine rendered it an object of attention. The kite competition at Vincennes, which the writer was called upon to judge, was several times postponed for lack of wind and had little interest, since the cellular kite of M. Lecornu was the only one possessing merit.

The Congresses of Meteorology and Aeronautics in 1900 are especially interesting as affording a general retrospect of the progress made by the twin sciences in the century just closing, and as giving a forecast of their possibilities in the next century, for meteorology and aeronautics are mutually dependent upon each other. The exploration of the air will give a better knowledge of the meteorology of the upper regions and perhaps will result in a more complete utilization of natural forces, such as solar energy and wind. The sea, at present the great medium of international communication, is only navigable on its surface, while the aeronaut can use a vast depth of atmosphere, and, while oceans separate continents, the atmosphere unites and dominates them. It is certain, therefore, as M. Janssen said, that man will not stop until he has conquered the last domain open to his activity.—A. Lawrence Rotch, in Science.

IN JUSTICE TO VESPUCCI.

[THE following communication has been received by the New York Times from Signor Gustavo Uzielli, a well-known savant of Florence, who has spent many years in endeavoring to destroy the popular schoolroom fallacy that owing to the mistakes of early geographers Amerigo Vespucci robbed Columbus of the honors that should have belonged to the latter. Signor Uzielli is the editor of the Toscanelli, a review, the object of which is to prove the obligations that Columbus was under to Paolo dal Pozzo Toscanelli through contemporaneous documents, and also to establish the real status of Amerigo Vespucci among navigators by the Vespucci manuscripts preserved in the Riccardiana Library. M. Harrisse, whose letter to Signor Uzielli is mentioned by the latter, has done much to throw light on the achievements of the Cabots in North America. In the letter in question he bids Uzielli to persevere in collecting and editing the Vespucci documents, which alone definitely show the true relations that existed between Vespucci, Columbus and Toscanelli.]

To the Editor of the New York Times:

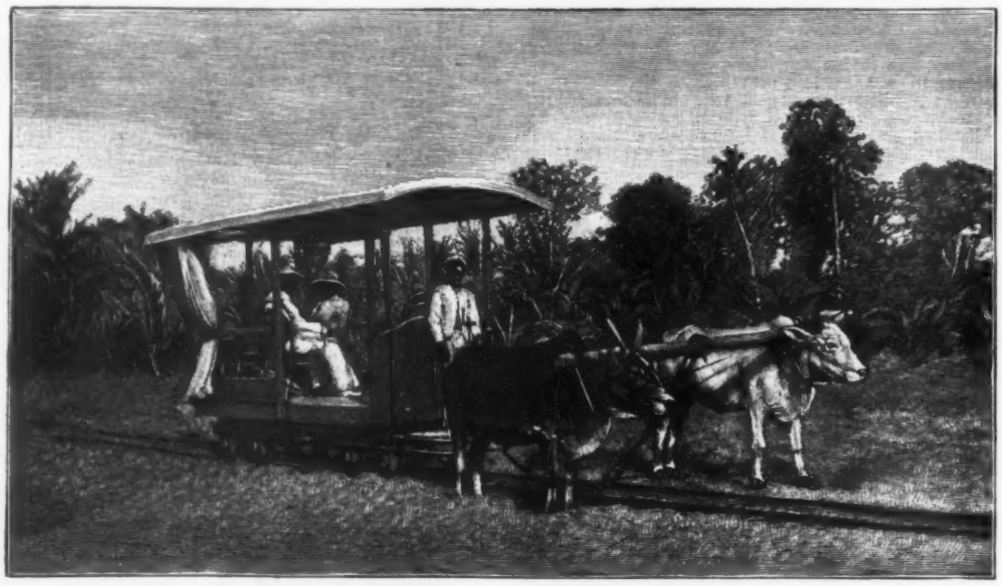
I have the honor of sending you a letter I have received from the distinguished scholar Mr. Henry Harrisse concerning the expediency of publishing the narrative of Vespucci's travels from contemporaneous manuscripts existing in Florence, until now reputed spurious, but whose authenticity I have established.

I beg your leave at the same time to answer the article published February 27, 1900, in your influential paper. In this article you did me the honor of commenting to your readers on the campaign I have undertaken with the purpose of destroying the unjust opinion held by many, especially in the United States, with regard to Amerigo Vespucci. This campaign you seem to consider uncalled for. (I want to acknowledge here the encouragement I have received from the American press in general in my efforts to render Toscanelli better known and to clear the fame of Vespucci. Thus the Nation of New York, January 26, 1893, in a notice of the first number of the periodical Toscanelli, which was issued January, 1893, gives an account of my first researches of the Vespuccian manuscripts, and remarks: "Historical scholarship never, we believe, launched a more solid and scientific periodical than Toscanelli." Unfortunately, this praise did not save the publication from dying for want of subscribers.)

You say, among other things: "Perhaps if the illustrious professor would study old histories less and new ones more, he would join us in a smile at the needlessness of his admonition. Of course, Americans in the past joined in the general mistake about the character and labors of him whom the professor calls 'the Dreyfus of the centuries,' and our writers and orators joined in the denunciation of the man who was supposed to have fastened his own name on the country discovered by another; but that was some time ago, and since then all of us who pay any attention to such matters have learned and frankly admitted that Vespucci was probably an amiable and able old fellow, against whom Columbus had no grievance whatever."

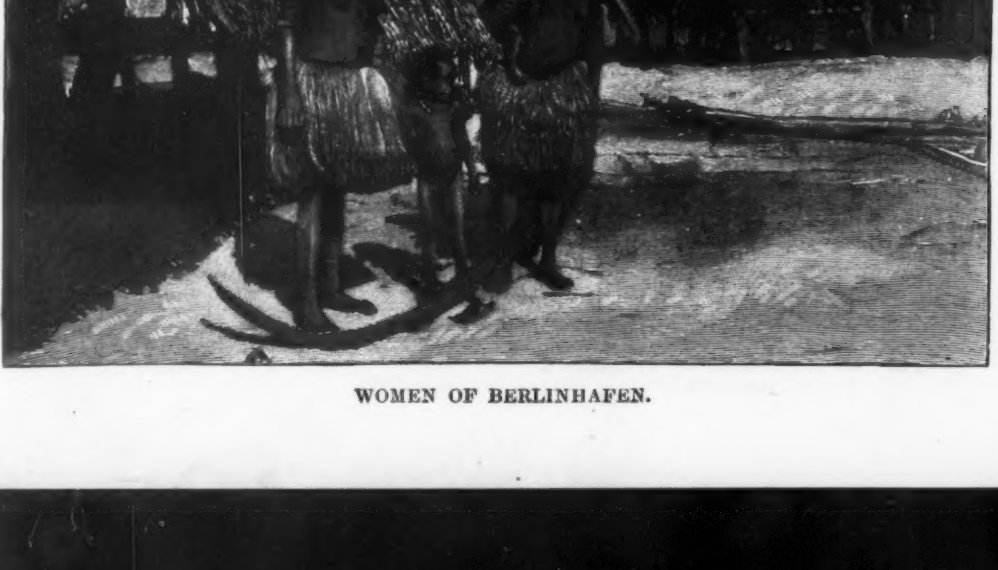
THE VESPUCCI OF TRADITION.

Now who are the American authors who have contributed to form in me the opinion you consider erroneous? One might perhaps call old the illustrious Emerson, who, writing in 1856, calls Vespucci "a thief and the pickdealer of Seville," but can one call old the no less illustrious Blaine, who with his assistants in 1892, the year of the Columbian festivities, rechristened America to the shame of Vespucci, and gave her the name of Columbia? And the equally well-known Markham, who, in 1894, calls Vespucci a "beef contractor"? Can one call old and incompetent John Fiske, the historian of the discovery of America, and Elias Hall, the secretary of the American Geographical Society, who in the above-mentioned year of the Columbian Centennial, 1892, allude to the shameful imputations cast upon Vespucci in the United States, and state the need of rewriting his history? And is not this the opinion expressed but last year by the above-mentioned Hall in his mention of my works in the Bulletin of the American Geographical Society, by Haebler, in the Literarisches Centralblatt, by Marcel, librarian of the



THE OXEN-RAILWAY OF STEPHANSORT.

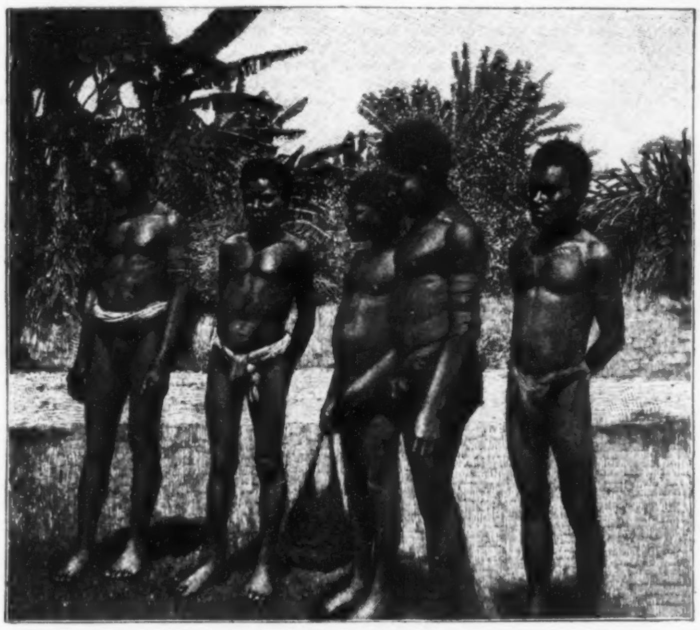
STATION-HOUSE OF BERLINHAFEN.



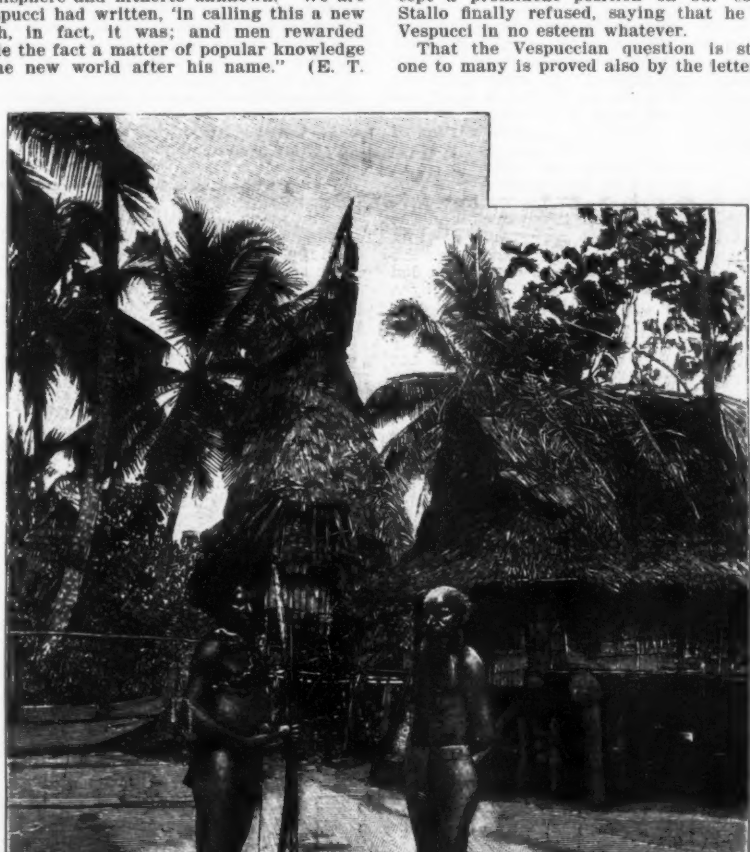
WOMEN OF BERLINHAFEN.

geographical maps in the National Library of Paris—all quoted by me in the Italian Gazette—and finally by Mr. Harrisse?

Moreover, against those, who, like Blaine, protest against the name of America given to the new continent, may it suffice to quote another book published in 1892, on the occasion of the four hundredth anniversary of Columbus, in which another great American historian, Payne, writes: "Here at last is positive evidence of an enormous habitable land lying in the southern hemisphere and hitherto unknown. 'We are justified,' Vespucci had written, 'in calling this a new world.' Such, in fact, it was; and men rewarded him who made the fact a matter of popular knowledge by calling the new world after his name." (E. T. Payne, "History of the New World Called America," Oxford, 1892, Vol. I., pages 186-187.)



LABORERS FROM THE INTERIOR OF NEW GUINEA.



NATIVES OF TAMARA—TAMBORAN HOUSE IN THE BACKGROUND.

EVIDENCE OF MISCONCEPTION.

From what has been said above it appears that a few American scholars have a just appreciation of Amerigo Vespucci, but that the great majority, including the scholars not specialists in this subject, hold a different view. I am confirmed in this opinion by the following facts:

1. The United States has never decreed especial celebrations in honor of Vespucci, while such magnificent ones were held for Columbus.

2. In 1898 I was vice president of the committee for the celebrations in honor of Amerigo Vespucci and of Paolo Toscanelli. In the name of the Marquis Piero Torrigiani, president of the committee and Mayor of Florence, I begged J. B. Stallo, the eminent philosopher, formerly Ambassador of the United States to Italy, and at that time resident in Florence, to accept a prominent position on our committee. Mr. Stallo finally refused, saying that he held Amerigo Vespucci in no esteem whatever.

That the Vespuccian question is still a troubled one to many is proved also by the letter in which the president of the American Geographical Society, acknowledging the invitation of the Mayor of Florence, announces that he has sent us his representative to the above-mentioned celebrations, Captain Alfred T. Mahan, United States Navy, who, to our regret, was recalled by the breaking out of the war, before reaching his journey's end.

Books of such unchallenged scholarship as those just quoted, published no later than 1892, and the statement made by so prominent a man as Mr. Stallo, are the evidence which has led me to conclude that the prejudice against Vespucci is still prevalent in America.

Perhaps things have changed since 1892, or, rather, 1898. Your country travels with the speed of a lightning express, while our old Europe progresses at the rate of an accommodation train! Public manifestations indicating that this change of sentiment has really taken place among you would give me infinite pleasure.

Be it permitted me to add, however, that my incredulity as to radical change on this score is but confirmed by your very article in the New York Times, since you write these words in which frankly "I heard a sound as of the grinding of an ax": "The belief that the lesser explorer took a part of his name from, instead of giving it to, the new continent, is certainly as widely diffused in the Western as in the Eastern Hemisphere, so why, pray, are we charged by Prof. Uzielli or anybody else with ignorance and ingratitude?"

AMERICA VS. AMERIGO.

If I have well understood the friendly irony of these lines, your opinion is that Amerigo, instead of giving his name to, has taken his name from, America. Such, indeed, was the opinion sustained by the distinguished geologist Marcou before the congress of Americanists at Paris, in the year of the Columbian Centennial. One of his fundamental arguments was the following. (Congrès Internationale des Américanistes, Compte Rendu de la huitième session tenu à Paris en 1892, page 132.)

"One of my Italian friends, who is at the head of an important administration and resides in Florence, has written to me that the name (viz., Amerigo) is quite unknown to him as a Christian name, even after the celebrity imparted to it by Vespucci, and is certainly not in use in Italy."

Incredible! And more incredible yet is the childishness of those who, finding two Frenchmen owners of this name, or, to be more exact, two recorded by Dante and a third captain under Charles of Anjou, and finding, moreover, the equivalent names also in ancient Germany and in Hungary, conclude that America has taken her name from a Frenchman, a German, or a Hungarian. It is sufficient for my purpose to name merely Amerigo Donati, who in all histories of Florence is recorded as the leader of the nobles in the first half of the fourteenth century; the familiar d'Amerigo, or Amerighi, to which belonged four priors—first Francesco Amerigo, and later Benedetto Amerighi, Abbot of the Monastery of St. Maria, in Florence, who died in 1487; then Amerigo Amerighi of Pesaro, judge in Florence at the time of Franco Sacchetti, and finally the noble Amerigo Amerighi, of an ancient family of Siena, son-in-law of the actual Mayor of Florence, Marquis Piero Torrigiani. Indeed, as a Christian name Amerigo was common enough before it was rendered famous by Vespucci, and has been very popular ever since. And it was used for women as well as for men from the first centuries of Florentine history down to our present times, which see the family name of Vespucci dying out in the person of Ameriga Vespucci, Countess Talon. No writer of authority accepts to-day the theory upheld by Marcou except perhaps himself. All—be it sufficient to name the Americans Fiske, Payne, and Winsor—admit as established beyond a doubt that the reading of the "Travels of Vespucci" induced Waldseemuller to give in his "Cosmographiæ Introductio" the name of America to the new continent, in honor of the Florentine traveler. Allow me one more remark. In your article you place Vespucci among the lesser navigators, giving first rank to Columbus. I know not what rank you assign to Cabot, who in 1897-8 was commemorated in Canada as being the first who had set foot on the American continent, or what importance you assign to the navigations of the Norsemen in the tenth century.

THE REAL DISCOVERER OF AMERICA.

In truth the discovery of America is not due to one single navigator. None can be considered as its only hero. Therefore, Carlyle was right in not placing the discoverer of America among the chief heroes of the world, although the discovery of the new continent is the principal event in the history of humanity. The discovery of America tends to confirm the theory that all the great evolutions of history must be brought about by economic causes. It was due chiefly to the closing of the commercial highways between Europe and Asia, consequent upon the invasions of the Tartars and the Turks, the Asiatic peril of the fifteenth century, as the Chinese revolution is the Asiatic peril of the twentieth. The need which impelled Europe to keep open the ways of communication with the Far East and rendered the discovery of America inevitable is the same which renders inevitable to-day the European-American coalition against China to keep open that vast empire to the commerce of the world.

The economic inevitableness which caused the discovery of America is precisely the thesis I have developed in my work on Toscanelli. My fundamental conclusions have been approved by competent European critics, among whom I shall name but one of the most distinguished modern historians—Ludwig Pastor. [Historisches Jahrbuch, Bd. xvii., 1895. Heft I., p. 206.] Allow me to outline the leading idea of my book.

Prince Peter of Portugal was in Venice at the beginning of the fifteenth century. There he saw the incipient decline of the Venetian commerce with the East, owing to the advance of the Turks, before whom the highest dignitaries of the Byzantine Empire were seeking refuge in the very city he was visiting. With quick intuition the Prince foresaw that Portugal might become the new commercial headquarters of the ships which brought spices and other merchandise from the Far East. The Republic of Venice knew no more welcome gift to offer Prince Peter than a beautiful codex of the Milione of Marco Polo.

At Florence the Prince must undoubtedly have become well acquainted with Toscanelli and have established intimate relations between the Court of Portugal and the learned Florentine. The principal proofs of this fact are the interview which took place in Florence in 1459 between the Florentine astronomer

and the Portuguese Ambassador (Uzielli, G.—Colloquio avvenuto in Firenze nel Luglio 1459 fra gli Ambasciatori del Portogallo e Poalo dal Pozzo Toscanelli. Roma, 1898.—Estratto dalle Memorie della Società Geografica Italiana. Vol. VIII., 1898), and, secondly, the interviews that the former had in Rome with Canon Fernando Martins of Lisbon, and the letters which he subsequently wrote to the latter in answer to the questions asked him by King Alphonso V. of Portugal. In these letters was outlined the ocean course to the Land of Spices—that is to say, China and the neighboring isles. This course, as is testified by Las Casas, was faithfully adhered to by Columbus, while other testimony proves that Toscanelli, moreover, traced for the King of Portugal a course for the circumnavigation of Africa, also leading to India.

TOSCANELLI'S WORK.

This was the course followed by Vasco de Gama in 1498. (Uzielli G. e Celoria G.—La vita e i tempi di Poalo dal Pozzo Toscanelli. Roma, 1894. Vol. I. of the Fifth Part of the "Raccolta Colombiana.") At all events, the Congress of Antwerp, in 1873, justly proclaimed Poalo Toscanelli to be the inspiring spirit of the discoverer of America.

Prince Peter, having returned to Portugal, induced his brother to assume the scientific direction of the ocean expeditions in search of a way to Asia by either of the two above-mentioned courses traced out by Toscanelli. Many tried in vain to sail the westward course, a feat accomplished later by Columbus, Vespucci, Cabot, and many others. But Blaine in his book, quoted above, observes, justly: "Had not Columbus discovered America in 1492, a hundred Columbuses would have discovered it in 1493." (Columbus and Columbia. Boston, 1892. Page 45.) And if not in 1493, certainly before the close of the century. As a fact, the true origin of the discovery of America is to be sought in the evolution of civilization, and not in one only hero, be he Toscanelli or Columbus—Toscanelli because he pointed out the way, but did not follow it himself; Columbus because he holds the only record of having arrived first.

But nevertheless it is just, perhaps, that a Florentine should have given his name to the new world, since, though Columbus arrived first, from Florence—that is to say, from Toscanelli—came the great impulse that sooner or later had to bring about the great discovery. And Vespucci, indeed, not Columbus, sailed along vast stretches of the coast of the new continent and was the first to realize the importance of the discovery.

While I am trying to overcome the difficulties that stand in the way of a faithful publication of the narrative of the travels of Amerigo Vespucci from the Florentine manuscripts, until now erroneously considered forgeries, I see numerous Americans, especially of the gentler sex, who are visiting Florence, in spite of a very hot summer. May I hope that, among the many treasures of this city, they have also visited the place where are kept the relics of the inspirer of the discovery of America and of him who has given America a name, considering that, in substance, this discovery was but the outcome of the high culture of Florence at the time of the Renaissance?

And, if this pilgrimage has taken place, may I consider it due to a change of sentiment concerning these two illustrious Italians brought about by the American press?

With this hope, I have the honor to remain, my dear sir, GUSTAVO UZIELLI.

Florence, September 20, 1900.

THE MECHANISM OF AMPHITHEATERS.—II.

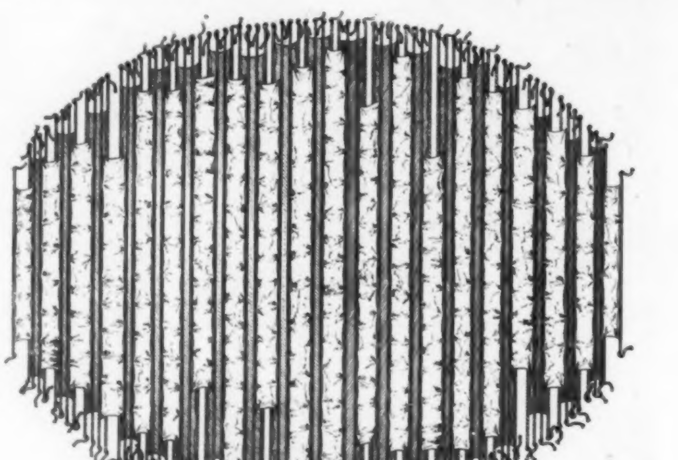
IN the SUPPLEMENT, No. 1305, we published an article entitled "Some Roman Amphitheaters;" now we describe some details of the mechanism by which the Romans were enabled to enjoy the spectacles in comfort and safety. As we have already shown, the floor of the arena was all cut up by large troughs and trap doors, which may be compared to the "bridges" and "traps" of the modern theater. The Colosseum at Rome was no exception to the rule, and though the ruins are not in as perfect condition as at Capua and Pozzuoli, still enough remains to show how the galleys were launched and how the animals were admitted to the arena. The arena may be said to be divided into long narrow passages by a series of walls, some parallel to the major axis and others following the curve of the oval. The dens for the beasts were arranged around the oval; they were 8 feet wide, 5¼ feet deep, and were constructed of brick-faced concrete. In the vaulted roof of each was an opening for the introduction of food; the front of each cage had a grating. Travertine corbels in pairs supported the lower masts, which in the Colosseum served to hold the lower end of the awning, for in this amphitheater the awning only protected the spectators and did not cover the arena proper. These supports for the masts were built right into the dens.

In the floor at the front of the dens, forming a ring around the arena, was a drain or water channel, which was used to give the animals water to drink. Water still flows through this channel. In early times the cages were probably brought up to the level of the arena by inclined planes, which still exist; they were evidently drawn up by windlasses. A great portion of the scenic machinery was of wood, and the absence to-day of this timberwork leaves the archæologist in some doubt as to the actual arrangements; but it seems well determined that a number of lifts were constructed in four of the straight passages, and the late J. H. Parker made an able restoration of it in his "Flavian Amphitheater," which we reproduce. An animal is represented first as coming out of his den into a cage; next the capstan is seen, followed by a cage in midair, the ropes or chains passing over pulleys. At last the cage reaches the level of the arena, and the cover is thrown up, either automatically or from below. Grooves can be traced to-day in the ruins which served to guide the cages in their ascent. The cages had two doors, one at the end and one at the top. It is probable that there was a trap door at the top of each lift, and that the cover was pulled open by a cord from below just as the cage reached the floor of the arena. A number of massive bronze sockets, with dovetailed flanges set in great blocks of travertine, exist in various parts of the substructures. They bear marks of wear from the pivots. These must have been used for windlasses to raise heavy pieces of scenery or the cages of animals.

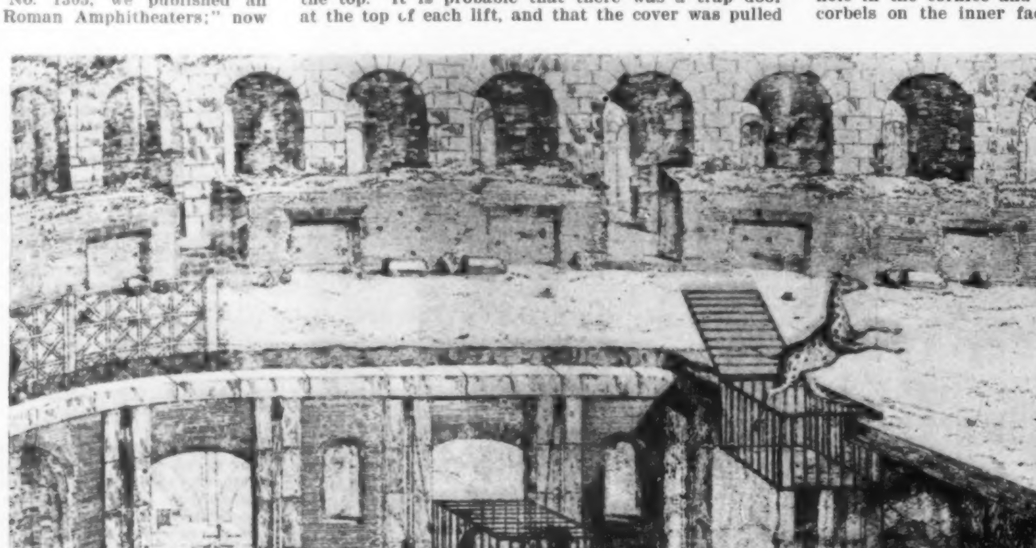
The persons in the lower tiers of seats were protected by strong nets and by bars that turned on pivots, so that the claws of the wild beasts had no hold on them. The scenes in novels such as "Quo Vadis" appear even more real after the diabolical ingenuity of the arrangements is understood. We must all deplore the butchery which occurred in the arena of this and other amphitheaters, but at the same time we must admire the misdirected efforts of the Roman engineer. There is no doubt that the effect of bringing a large number of wild beasts into the arena simultaneously was tremendous and spectacular in the extreme.

It will be readily seen that the heat of the sun would undoubtedly cause great discomfort to the audience, which sat for hours watching the sports in the arena. In most amphitheaters an awning only extended over a portion of the inclosure, but at Capua the whole space appears to have been covered by an awning or rather an ingenious series of awnings, as shown in our diagram. There must have been travertine corbels all around the top of the amphitheater to hold the wooden poles which supported the awning over the heads of the spectators. A whole army of sailors was employed to furl and unfurl the awning. The spectators in the Capuan amphitheater were shielded from the sun and rain by an awning made in thirty-nine sections. One end of the awning could be run across the shorter axis of the building independently of the other. The sections of awning were arranged to overlap, so that when all of the awnings were set the entire cavea and the arena were covered.

In the Colosseum at Rome, as already mentioned, the awning only protected the spectators. The cornice was 160 feet from the ground, and built into it were stones pierced with a round hole. Fourteen feet below each hole a large travertine corbel projected from the face of the wall; the top of the corbel was countersunk. The wooden pole was dropped through the hole in the cornice and rested on the corbel. Other corbels on the inner face of the wall held a corresponding set of wooden uprights. The two masts were about 6¼ feet apart, and they were probably lashed together so as to make a stiff support, as the strain on the ropes must have been great. The awning sloped away from these masts until the poles were reached



AWNING OF THE AMPHITHEATER OF CAPUA.



THE CAGE LIFTS OF THE COLOSSEUM OF ROME.

which were grounded in the corbels which projected from the animals' dens. Of course, these poles were tall enough to raise the awning sufficiently to allow the spectators on the topmost seats to see the arena. At the time of Rome's greatest extravagance the awning and ropes were made of silk. Traces of a wooden gallery for the sailors who operated the awning still remain. The problems we have considered were two of the most interesting of the engineering achievements of the Romans, though not the greatest.

DISTRIBUTION OF SEEDS BY WIND.

IN the course of his lecture before the Royal Horticultural Society on "The Dispersal of Seeds," Prof. G. S. Boulger made the following interesting observations on the adaptation of fruits and seeds to dispersal by wind, says The Gardeners' Magazine. This, he said, may be roughly divided under three categories: First, lightness, whether of the seed, fruit, or entire plant; second, wings; third, plumes or parachutes. It is undoubtedly significant that it is especially among parasites and saprophytes—plants that more urgently require a wide dispersal of their abundantly produced seed—that we meet with some of the most striking instances of extremely light seeds. Orobanche, Monotropa, Purola, and many orchids are cases in point, Goodyera repens, for example, having seeds which weigh only .000002 gramme each.

Small light seeds are also often combined with the somewhat simple adaptation known as censer action, as in many Caryophyllaceæ, poppies, etc. The inflated pods of the bladder senna (Colutea arborescens) may merely catch the wind while still on the plant, so as to jerk out the seeds separately as they sway in the breeze, or they may break off and be carried balloonlike to somewhat greater distances. As we might expect, it is especially among the plants of those wide-stretching level tracts of arid ground, the steppes of Eastern Europe and of Asia, where plants have often so great a difficulty in sustaining life at all that we meet with instances of this class of adaptation. The fruit of Cachrys alpina, one of the Umbelliferæ of these regions, for example, measures 13 mm. by 10 mm., but weighs only .07 gramme, while another species of the same genus, from Shiraz, measuring 15 mm. by 10 mm., weighs only .06 gramme. The spirally coiled legumes of some species of Medicago may also be cited in this connection; but more interesting still are those cases in which various subsidiary structures become detached, or even the whole plant is rolled away by the wind. In Trisolium subterraneum, and allied species, for example, the calyx-teeth of the abortive flowers form a loose globular cage round the head of legumes, and the whole of the ball thus formed breaks off and is rolled along by wind. In the wig tree (Rhus cotinus, a familiar garden shrub), most of the branches of the inflorescence are barren, forming merely reddish feathery arms, one branch which bears a drupe becoming detached together with all this "wig," and being in consequence readily blown about. Similarly in the Australian grass Spinifex squarrosus the entire head, the bracts of which are long and spiny, breaks off when the fruits are ripe, and is blown about in the sand. The rose of Jericho (Anastatica hierochuntica), one of the Cruciferæ, which is now commonly sold as a curiosity in London, is a type of those steppe plants which become detached whole from the ground during the arid fruiting season, when the soil is cracked by heat. Its branches, bare of leaves, but still carrying the fruits, bend inward, forming a dry ball of wicker-work. This inward bending may help to uproot the tap-root, as does the outward bending of the branches in the case of a physiologically similar plant, Plantago cretica, described by Kerner. The whole plant is then blown along until it reaches moisture, when both branches and fruit-valves open out hygroscopically. It has been suggested that this plant is the "Galgal" of Psalm lxxxviii. 13, translated "wheel" in our English Bibles. There are also a considerable variety of herbaceous plants on the Russian steppes, of which Alhagi camelorum, Salsola kali and Centaurea diffusa—plants belonging to very diverse families—may be mentioned as examples, in which the base of the aerial stem decays, so that all the rest of the plant is liberated. These dry, rigid, branching plants are rolled together by wind until they accumulate in the huge balls known as steppe-witches or wind-witches.*

We come next to the great series of plants in which wind-dispersal is facilitated by wing-like structures attached either to fruit or seed. Among these we shall find representatives of a very large number of natural orders, and a great variety in the anatomical or structural origin of the "wing" itself, showing that this mode of seed dispersal has originated independently in many groups, and has been evolved along many independent lines. Nevertheless, as Sir John Lubbock has pointed out, they agree in many physiological or adaptational characters; as, for instance, in occurring almost always on trees or climbing shrubs well exposed to wind, and in having the seed generally in an eccentric position.

Beginning with those wings which are attached to fruits, we find that we may further subdivide them into three or four groups. In some the wing is in origin a bract, as in the hop, Humulus lupulus, the hop-hornbeams, ostrya, the spinach (Spinacia), and in such members of the order Nyctagineæ as Bougainvillea, where the bract has previously served to attract fertilizing insect-visitors, and Mirabilis. Here, too, we must class the numerous grasses, such as species of Briza and Melica, in which glumes adhere to the fruit and serve more or less as wing. Here, too, belongs that beautiful structure, the adherent leafy bract in the lindens (Tilia), to which the weight of several fruits is so eccentrically attached as to give it in falling the same screw-propeller action that we have in the wings of maples—an action which enables a very slight breeze to carry it beyond the overshadowing of the parent tree.

Next we have a variety of instances of wings originating in the perianth, generally the calyx. Such are the three leafy wings in Triplaris surinamensis, Cham, one of the Polygonaceæ, the allied but dissimilar wings in the docks (Rumex), and the similar but not allied wings in the Dipterocarpaceæ. Froelichia, one of the Amaranthaceæ, has a two-winged perianth; and thrift (Armeria maritima, Willd.) has a parachute-like membranous outgrowth of the accrescent calyx-limb.

Lastly, there is an even graeter variety of wings formed from the pericarp itself, though here we ought undoubtedly, in anatomical strictness, to distinguish between "inferior" ovaries, such as the three-winged fruits of begonia, where the wing is perhaps rather of perianth origin, and such "superior" ovaries as the "samaras" of the maples, elms, and ashes. On the one hand there are also the Combretaceæ, such as Terminalia and Quisbualis and the well-known Ailantus glandulosa, Desf.; on the other, such Leguminosæ as Pterocarpus and Centrolobium, and one of the two suborders of Malpighiaceæ, including the maple-like fruits of Banisteria, Triopteris, Tetrapteris, and others.

Though performing an absolutely identical function to that of the wings of fruits, those of seeds are obviously of entirely different origin. It is interesting to notice here what appear like the first stages of such an adaptation, where, for instance, in the genus Pinus we have every gradation between no wing at all and one of considerable size; or where, as in Lilium, Fritillaria, Tulipa, Agapanthus, Funkia, and other members of the order Liliaceæ, or in Rhinanthus, Veronica, and other Scrophulariaceæ, we find seeds for the most part only slightly flattened, or with a comparatively narrow and thick wing. On the other hand, a large proportion of the Bignoniaceæ, such as Bignonia, Tecoma, Eccremocarpus, Catalpa, Wellingtonia, or Spathodea, the genus Deutzia in Saxifrageæ and Zanonia macrocarpa, Blume, a cucurbitaceous plant in the Sunda Archipelago, exhibit this character in its highest perfection, having broad and delicate wings of feathery lightness.

Under the name of "parachutes" we might include such membranous expansions of the border of the calyx as we have mentioned in the thrift, and as occur in some Labiatæ and Scabiouses; but we will speak now only of hairy or feather-like appendages. Like wings, these must structurally be sharply divided into two main groups according as they are attached to the fruit or to the seed. The former of these groups again presents great variety of structural origin, the feathery process being developed from style, corolla, calyx, pedicel, or glume. In the old man's beard of our hedgerows (Clematis Vitalba, L) in some, but not all, species of the allied genus Anemone, notably in the beautiful pasque-flower, A. Pulsatilla, and, by one of those interesting parallelisms between the orders Rosaceæ and Ranunculaceæ, in Dryas, and some species of Geum, the style persists as a feathery awn. In the myrtaceous Verticordia oculata the fruit is crowned by five persistent petals, each consisting of a fan of ten palmately arranged but pinnately divided feathery lobes, a most beautiful, exceptional, and highly specialized adaptation. The labiate Micromeria has the five teeth of its calyx fringed with hairs; the long, simple hairs of the cotton-sedge (Eriophorum), now known, believe, in commerce, as "arctic wool," represent a perianth; while all the varieties of "pappus" among the Compositæ are developments from the margin of the calyx-tube. In connection with these last-mentioned plants, I would remind you that we have some Compositæ with a trace of a limb to the calyx and many without any pappus; while, when present, the pappus may be sessile at the apex of the fruitlet, as in the thistles, or carried up on a long, slender stalk-like tube, or "stripes," as in the dandelion; and its hairs may be simple (pilose) or feather-like (plumose). The hygroscopic character of these hairs gives them some effect in levering the fruitlets off the common receptacle, in connection with which action I would also remind you of the remarkable change of form of the common receptacle in the dandelion (Taraxacum) from concave in the flowering stage to a taut convexity when in fruit. The tufts of hair in the reed mace (Typha) proceed from the pedicels; while the well-known long tail-like plumes of the feather-grass (Stipa pennata), one function of which, as Dr. Francis Darwin has demonstrated, is to bury the fruit in the ground, are awns proceeding from the species of glumes.

* Kerner, "Natural History of Plants," English edition, vol. ii., p. 850.

CRYPTOSTEMMA LUSITANICUM.

THIS new annual has the merit of being extremely free blooming, with the drawback that its flowers close as soon as the sun ceases to shine upon them, or usually between 1 and 2 P. M., and on dull sunless days they sometimes do not open at all. The flowers are of a pale shade of yellow, with dark brown centers, and rise about 8 inches from the ground, each of them on a separate stem. They are well and accurately

CRYPTOSTEMMA LUSITANICUM.

represented in the accompanying woodcut.—The Gardeners' Chronicle.

EFFECT OF INCANDESCENT GASLIGHT ON PLANT GROWTH.

TWENTY years ago Sir William Siemens made a series of experiments on the influence of the electric light upon vegetation, a detailed description of which he read before the Royal Society on March 4, 1880. A series of similar experiments with incandescent gas are described by Mr. J. J. Willis in a recent number of the Gardeners' Chronicle. Mr. L. C. Corbett carried on his experiments in a greenhouse at the West Virginia station, during the years 1895 to 1899, with lettuce, radishes, spinach, tomatoes, sugar beets, and seedling cabbage, mainly from an economic standpoint. Eight Welsbach incandescent burners were used in the experiments, and these were so alternated in position from time to time as to overcome local temperature and light differences.

The experiments with lettuce involved twelve distinct crops and nearly 10,000 plants. Transplanting the young plants from pots and using an artificial light only during the period the plant occupied the permanent greenhouse bench, were adopted after comparative trials as being the best method for the growing of lettuce on a commercial scale. The plants grown in artificial light were taller, heavier, grew faster, and matured quicker than plants grown from the same lot of seed under normal conditions. In one experiment 400 plants exposed to the stimulating influences of the artificial light for forty-six nights weighed 68½ pounds; while a similar lot grown under normal conditions weighed 49½ pounds, an increase in favor of the former of 38¾ per cent.

Radishes were grown between the rows of lettuce, as is commonly practised in commercial houses. The artificial light notably increased the development of the tops of the radishes, and slightly increased the size of the roots. The heliotropic effect of the incandescent light was greater with radishes than with any other plants grown. The stimulating influence of the incandescent light, on the other hand, was greatest with spinach. It caused the production of seed shoots in the row to a distance of nearly 8 feet from the light. Spinach-plants subject to the influence of the light, grew faster and completed their growth in less time than plants grown normally.

The records of the yield, and the date of first bloom of tomatoes grown from seed and also from cuttings, show no increase in weight of the fruit grown in the light, though the blossoming period was from eight to eighteen days earlier, and the individual fruits were generally larger than when grown under normal conditions.

With sugar-beets, the tops, sugar-content of the roots, and percentage of purity were considerably increased by the use of the incandescent gaslight. The largest and heaviest roots, however, were grown under normal conditions.

The range of stimulating influence of the incandescent light was somewhat variable for different crops. In general, the maximum growth was attained at 12 to 16 feet from the light, while a perceptible increase was noticed at 24 feet. The stimulating influence of the light as indicated by the growth of plants used in the various tests, is shown by the order in which the sorts are named, the first being the most susceptible: Spinach, cabbage, radish, lettuce, tomatoes.

In a study of the periodicity of plant-growth as modified by the influence of the artificial light, it was found that the most active period of growth of lettuce subject to the influence of the incandescent gaslight began at 11 P. M., and continued until 9 A. M.; while with the plants grown under normal conditions the most active period of growth began at 4 A. M., and continued until 11 A. M. In the first instance the period of growth was ten hours, and in the second, seven hours. In these experiments it is reported that no injurious effects resulted from the use of incandescent gaslight.

NEW METHOD OF TESTING GLASS SURFACES.

By EDMUND M. TYDEMAN.

ONE of the most serious practical difficulties in the manufacture of fine compound achromatic object glasses of large aperture is that experienced in applying a satisfactory test to the convex surfaces of the lenses of which they are composed; and so great an obstacle has this proved, that opticians to-day are not using those combinations of curves in their object glasses that most commend themselves to their judgment as forming the best solution to the complex problem involved in the mutual destruction by each other of the opposing aberrations, because it calls for the employment of three or more convex surfaces; while for testing the one convex surface that it is imperative in any case to employ, they have recourse to an inferential method, or to a tedious empirical process.

For example, that "form" of object glass that would yield the maximum field of view with relative excellence of image for some considerable distance from the optical axis is seldom or never used except in the case of very small object glasses, because it involves the accurate working of no less than three convex surfaces out of four; and in describing their new photo-visual three-lens object glass, Messrs. Cooke remark, "there are thus three concave surfaces whose figuring can be directly tested by reflected light, while each of the remaining three surfaces being convex can only be tested for figuring in an indirect manner," by a method which they proceed to describe in detail, involving the employment of a liquid between the several lenses, a messing and tedious job at the best.

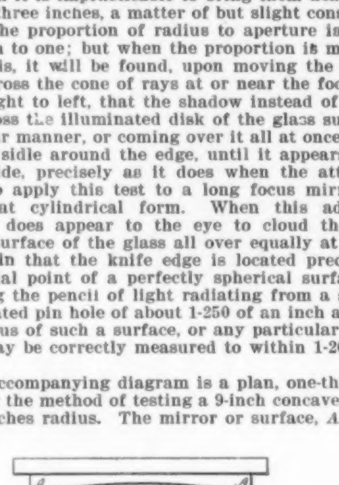
It is well known that the correctness of the figures and curves of nearly all polished concave surfaces can be readily tested by means of the very simple and ingenious methods devised by the late Prof. Foucault. It should, therefore, be a matter of no small satisfaction to have pointed out a simple plan by which his convenient and accurate method of testing may be applied with almost equal facility to convex as to concave surfaces.

All that is requisite in order to do this, is to take a cast of the surface to be tested in a suitable black cement; although it has been a matter of some difficulty to find a compound that would (1) conform itself accurately to the polished glass surface, (2) which would maintain its figure perfectly for a period sufficiently long to admit of careful scrutiny from its center of curvature, (3) with a surface sufficiently uniform and reflective, (4) that would not attach itself to the polished surface so tenaciously as to need great force for its separation, (5) and that could be applied directly to the glass surface while still warm, without the intervention of any foreign substance whatever, and yet would not adhere strongly to it. The compound that has been found to fulfill these conditions is made by melting together the best white paraffin wax with a trace of fine "water white" resin, into which is to be sifted a sufficient quantity of finely pulverized lampblack. As paraffin wax differs considerably in the quality of hardness, the proportion of resin required will be a matter of experiment, the wax sometimes being found sufficiently hard for use without it.

A cast iron back, the same size as the surface to be tested, having tied around its edges a strip of paper forming a rim from a quarter inch to one inch in height, according to the depth of the convex surface to be tested, is laid upon a level table, having first been slightly warmed; upon this plate is poured the melted cement; when it has become nearly cold, the paper rim is stripped off and the surface moulded to the contour of the glass surface by pressing it upon it. Or should this be found inconvenient the cement may be poured directly upon the glass surface, but in this case the glass must be very dry, cold, and clean, and the cement must not be heated more than just enough to allow it to flow freely, or it will be sure to adhere to the glass; the flat metal back can then be warmed just sufficiently to make it adhere to the wax, and at once be cooled off by sponging with cold water. When the whole has become quite cold, it will be found that the wax can be readily detached from the glass by the hands, assisted with a few gentle taps from a raw-hide mallet.

The concave wax surface can now be tested in the usual way by the Foucault method. If, however, the radius of the surface be very short compared with the aperture, the process must be modified in a way that will be readily understood by any one at all familiar with it, by means of the accompanying diagram, in order to bring the conjugate focal points closer together than is possible by M. Foucault's original plan, in which it is impracticable to bring them nearer than two or three inches, a matter of but slight consequence where the proportion of radius to aperture is greater than ten to one; but when the proportion is much less than this, it will be found, upon moving the straight edge across the cone of rays at or near the focal point from right to left, that the shadow instead of advancing across the illuminated disk of the glass surface in a regular manner, or coming over it all at once, will be seen to sidle around the edge, until it appears on the other side, precisely as it does when the attempt is made to apply this test to a long focus mirror of a somewhat cylindrical form. When this advancing shadow does appear to the eye to cloud the illuminated surface of the glass all over equally at once, it is certain that the knife edge is located precisely at the radial point of a perfectly spherical surface, and by using the pencil of light radiating from a strongly illuminated pin hole of about 1-250 of an inch aperture, the radius of such a surface, or any particular portion of it, may be correctly measured to within 1-200 of an inch.

The accompanying diagram is a plan, one-third size, showing the method of testing a 9-inch concave surface of 27 inches radius. The mirror or surface, *A*, is supposed to be standing or otherwise supported edgewise upon a table, its center being some 6 or 8 inches above its surface on a level with the eye of the observer, *E*, and also with the flame of a lamp on the right hand at *H*. The flame of the lamp is surrounded with a screen of thin sheet metal that is pierced with a round hole about one-eighth of an inch in aperture. *N* is a small convex mirror of silver or similar metal about three-eighths inch diameter and highly polished. It is mounted on a small pedestal, so as to bring it about level with the eye, and with the center of the surface to be tested.



A pencil of light proceeding from the aperture in the lamp screen, *B*, is made to impinge upon the convex surface of the hemispherical mirror, *N*, and from thence (it being one of the conjugate foci of the surface, *A*) it proceeds to the concave mirror, *A*, from which it converges to the other conjugate focus, *c*, and enters the eye placed just behind it.

If the surface, *A*, be a perfect sphere, when the thin screen or knife edge, *e*, is moved across the cone of rays at its apex or focus, the whole of the illuminated surface, *A*, will be seen by the eye placed at *e* to darken all over instantly and in every part simultaneously; but should the minutest irregularity exist, it will be apparent as a patch or ring, more or less luminous, according to the magnitude of the defect, that will only darken before or after the darkening of the surface, generally as the screen is advanced from right to left, so as to cut more and more into the cone of rays represented by the dotted lines, *A*, *c*, *A*.

In order to measure the differing radii of these defective patches or zones, the rest of the surface must be covered over with rings or screens of paper, leaving only the particular part in question exposed. The knife edge being moved nearer to or farther from the mirror, *A*, by a graduated screw or rack work, *K*, reading to hundredths of an inch or less, and the eye being applied as close to the edge as possible, when the dark shadow seems to come over the particular ring or zone under examination equally from all sides at once, the distance of the knife edge from the mirror or surface, *A A*, equals precisely the radius of that zone, any difference between which and the rest of the surface can be read off from the graduated scale, *K*, *K*, attached to the movable knife edge.

In testing surfaces of short radii it is necessary that the small mirror, *N*, and the eye, *E*, should be brought as closely together as possible, otherwise an astigmatic or cylindrical effect will be given to the cone of rays that will prevent their true focus being determined.

To get the various parts of the apparatus, and the mirror, *N*, in place in the first instance, it will be found advantageous to substitute the flame of a candle or of a small lamp in lieu of the small mirror, *N*; the reflected image of the flame can then be received on a piece of white paper and the mirror, *A A*, be moved about until the approximate position of the small mirror *N*, and of the knife edge, *e e*, is determined.

The "principal" focus of any regular concave reflecting surface, or of any part of such surface, can readily be measured in this way with perfect certainty to within 1-500 of an inch.

ARSENICAL SULPHURIC ACID.

THE recent epidemic of beer poisoning which has created so much commotion in Manchester and Salford, and to a less extent in other North of England towns, has, as readers of the daily papers will be aware, says Engineering, been traced to the use by certain brewers of an impure glucose containing arsenic, which injurious ingredient was derived from the sulphuric acid used in the manufacture—at least, this is the firm conviction of those who have gone into the subject, though until expert evidence is given at the adjourned inquests on the supposed victims, it would be premature to speak as if the whole mystery as to the amount of injury the arsenic has worked had been definitely ascertained. With the general facts of the epidemic, and with its ultimate outcome, as far as fixing the blame on certain persons is concerned, we are not minded here to speak; it is only in the way of discussing one or two points in connection with the manufacture of commercial vitriol or sulphuric acid that we have sought to emulate the example of our daily contemporaries by making some reference to the subject, which is one, to judge by the tenor of some remarks we have read, evidently of considerable novelty to many of the scribes.

The fact that ordinary vitriol, as made from Spanish pyrites, contains varying percentages of arsenic as an impurity, is well known, and there can be but few users of the substance—except, perhaps, those who employ it for such nefarious purposes as personal assault—who are not quite alive to it. In the earlier days of the manufacture it was not so, as the acid was made from brimstone, which may be considered as free from arsenic, though in common with many other bodies, it may sometimes show traces of it. It is now many years ago since a rise in the price of brimstone led to the use of British, and then Spanish pyrites, the latter substance at the present day being the raw material almost exclusively used. This pyrites as obtained from the Rio Tinto and Tharsis mines contains varying amounts of arsenic, an impurity which has caused the copper smelting interest a vast amount of trouble. The ore, when pure, contains about a third each of iron, copper, and sulphur, but as imported to England for use in the alkali manufacture it has more the composition of an iron pyrites, the percentage of copper being only about 4 or 5. It has been suggested that some of the ore imported during this year may have been much more highly arsenicated than usual, and thus have led to the greater impurity of the acid made from it.

The ore, known as mundic in Cornwall, from which the arsenic of commerce is obtained, is well known to occur under its more general name of arsenical pyrites at the Spanish copper properties, and it is no extravagant assumption to suggest that a vein of this pyrites may have been struck without any special attention being drawn to the fact. Color is certainly lent to this supposition by the fact that the amount of arsenic found recently in acid made in the North of England was decidedly greater than is ordinarily supposed to be present. A German authority gave a few years ago some figures which he had obtained in the analysis of English commercial acid, and the arsenic present was given as 0.2 per cent. Against this it is to be noted that Prof. Dixon, of Owen's College, has recently reported finding 1.4 per cent, a decidedly high figure showing unusual contamination. It may be mentioned that where a series of chambers are connected up to a set of pyrites burners, the amount of arsenic found in the vitriol of the first chamber will greatly exceed that found in the acid of the succeeding chambers; indeed, the figure may rise as high as 5 per cent. This fact is, of course, well known to the manufacturer, and advantage is taken of it to prepare the well-known Cooper's sheep dip from it by precipitating it with a current of sulphureted hydrogen. However, to make the pure acid purposely by this proceeding would hardly prove a profitable undertaking, and it has long been the custom where an arsenic-free acid is stipulated for to use brimstone as the raw product. This brimstone acid, as it is commonly called, in order to emphasize its freedom from arsenic, is made specially by certain firms in the North of England, as there is a regular demand for it from manufacturers of mineral water; a fact which seems to put those users of the acid, who also make articles intended for human consumption, in a rather delicate position, if it can be proved that they have not exercised the same degree of caution in this respect as have the mineral water manufacturers.

The present scare may result in showing that in all cases it has been the intention to purchase arsenic-free acid, but that from some reason or other the intention has been frustrated. The fact that complaints have not arisen before, and that a great many samples of glucose, both imported and of home manufacture, have been tested, and found quite free from arsenic, certainly goes a long way to prove that the samples which have been found impure, are the victims of some unfortunate *contretemps* rather than of premeditated design or criminal negligence. In one of the communications to the press, by the way, it is evidently taken that B.O.V. stands for best oil of vitriol; but although it might be possible for legal acumen to prove that this is so, to the ordinary person who has dealings in the acid it stands for brown or impure acid, and nothing more; and if any buyer fail to recognize this, it must be put down to the deficiency of his technical education.

Considering that the commercial acid costs about $15

a ton, and arsenic-free $20, and that only a few per cent of the acid is required to convert starchy matter into glucose, extra cost can hardly be pleaded by the sugar manufacturers, unless the competition in this line of business is very acute; though in saying this we are fully alive to the fact that there are many buyers of chemicals who will screw the manufacturer down to the lowest possible price—a course of conduct which, as we know well from various instances, is but an incentive to some sort of adulteration, and possibly one difficult of detection. At the present time, owing to the rise of cost in raw products and in fuel, many chemicals have necessarily been advanced in price, and where the buyer obstinately stands out against the advance, it is quite possible—we may almost say probable—that the manufacturer will reduce his quality so as to protect himself against absolute loss.

Sulphuric acid is used in the manufacture of other beer materials than glucose, but even if care was not taken to use the pure acid, there would be little danger to be apprehended, because unlike the case of glucose, where the arsenic may remain in the finished product, it would in the other cases to which we are referring be arrested or removed in an intermediate stage of the manufacture. All the same it is reassuring to find that it is the general rule—the universal rule, in fact, as far as our knowledge goes—for the manufacturers of these other bodies to use arsenic-free acid, and there can be little doubt, in the light of the recent stirring events, that brewers who use adventitious aids in the conversion of malt into beer will specify that the materials supplied must be free from any suspicion of the poison which has caused the present commotion.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Electrical Industries in Bangkok.—The development of the electrical industries in Bangkok presents some interesting features to the trade just now, says Hamilton King, Consul-General of Bangkok. The Bangkok Tramways Company, Ltd., received from the government in 1887 a concession for a street railway. This line was built in 1889 for horse cars and changed to an electric-trolley system in 1892. It is six miles in length, and has been doing a constantly increasing business and paying well from the start.

The city of Bangkok is at present lighted from an incandescent central lighting station. This plant was purchased in Great Britain in 1890 by a Siamese company for the purpose of lighting the King's palace and for the use of the public. It was not operated, however, until 1894, as the company met financial difficulties. In 1897, the plant was turned over to the Bangkok Electric Light Syndicate, which had a twenty years' exclusive franchise to furnish lights for the government and for the public; again, in January, 1899, it changed owners, going into the hands of what is at present known as the Siam Electricity Company. From the time this plant was turned over to the Bangkok Electric Light Syndicate, it has been operated well, and has proved a fairly paying investment.

The present company has increased its capacity from 10,000 to 17,000 lamps, and has installed at the present time over 10,000 lamps. The second annual report of the directors to the shareholders shows a dividend at the rate of 4 per cent for the half year.

Perhaps the most interesting feature just now is the fact that the Bangkok Tramways Company, Ltd., and the Siam Electricity Company are being consolidated under the name of the latter. This new company has just seured a concession from the government to build five and one-half miles of street-railway line through the most promising portion of the city of Bangkok. Thus it will be seen that the Siam Electricity Company now not only controls the concession for lighting the entire city, but such concessions as have thus far been granted by the government for building street railways. The capital of this company will be about $500,000 gold.

Orders for the supplies have already been placed, and it is expected that the road will be in operation by the end of next year.

Before consolidation, the light company furnished power only during the night, but since that time it is advertising electric power for both night and day use. This will probably be taken advantage of by many of the smaller manufacturing interests of the city and may in itself create quite a demand for electric supplies. In connection with this, it may be mentioned that the directors of the company have under contemplation the introduction of electric automobiles, to which they propose to furnish power. Few cities are better adapted to the use of automobiles than is Bangkok. The streets are absolutely level, and the pavement, which now covers many miles, is being rapidly extended in all directions.

Besides this company, there are thirteen private electric plants installed in the rice mills of the city; two of the forts have their own plants; five ships of the navy are lighted by electricity; the navy-yard is supplied with five or six portable dynamos; and a large installation is owned by the Bangkok Dock Company.

Another company is just now endeavoring to get a concession from the government to build a street railway on the other side of the river.

The city of Bangkok lies on both sides of the Menam. This river is quite wide, and has a tidal variation of from 6 to 11 feet. The current varies from that of a calm stream to the treacherous torrent of the high-water season. Water craft of every description abound—from the ocean steamer to the little ferry boat of the native. There is no connection between the two parts of the city, and, as a result, that portion lying on the left bank of the river has enjoyed all the modern improvements, while that on the right bank has been neglected. This condition of affairs, however, must soon change, for the new railway, which runs south to Petchaburee and will be completed within a year or two, will extend through that portion of the city on the right bank of the river and must cross the stream to find access to the present mercantile city, either by a bridge or by a closely connecting ferry.

All these developments in electrical lines have taken place during the last ten years, yet the growth to-day is far more rapid than ever before. The three companies that import electric supplies report that their business has more than doubled during the last twelve months, while to my personal knowledge their orders during the last two months have exceeded those of any twelve months previous. There is a large and rapidly increasing business along this line in Bangkok, and there is no reason why the United States should not get a generous share. The tendency is toward the American market. The orders for the entire supplies of the new tramway, during the last two months, have been placed in the United States, with the exception of the rails. The order for the rails went to England, because the company thought they were unable to secure the peculiar kind they wished in any other country. This, however, I believe, is largely due to want of information on the subject, a cause which more familiar acquaintance with our manufactures will no doubt set aside. Again, a large quantity of the American electrical goods used here comes through London and European houses. This is another obstacle that can be removed by our manufacturers placing themselves in direct communication with importers here. American goods are in favor, and the prices suit. The importers complain of American lack of promptness in attention to business. While goods are delivered here in three months from the time they are ordered from Europe and England, seven or eight months, and sometimes more, are consumed in getting them from the United States. This delay should be remedied. It is within my knowledge that answers to important cables have been delayed a full month.

I quote from a letter just received at this office from one of the leading importers of this city:

"My experience in doing business with the United States for the last ten years is that, generally, in the United States you get for the same money a better article than in most European countries; but, with few exceptions, American firms are not prepared for business with distant countries. Some of them have not even a cable address, and nearly all are slow and unsystematic in their correspondence. . . . Shipping arrangements to Siam are also defective, as much as four or five months sometimes elapsing between shipments from New York (whence we get most of our goods) and arrival in Bangkok.

"In consequence, we often prefer to order dearer or inferior articles from Europe, to avoid delay and uncertainty."

The packing of the goods, I am pleased to report, has been materially improved during the last year. While one lot has come in a most unfortunate condition, yet the importers, on the whole, report satisfaction in this line now. It is to be hoped that the improved condition of shipping with all the Far East that will come with our more direct communication with the Philippines will remedy some of these difficulties; and this, together with attention on the part of our manufacturers to those points to which reference has already been made in this article, will put America in possession of her share of this trade in Siam.

I call attention to the following extract from an interesting letter from Vice-Consul-General L. E. Bennett, which appeared in The Engineering News recently. Since Mr. Bennett wrote, I learn that the contracts are being made in this city and not in Copenhagen:

"With reference to present work in Siam, I beg to state the following:

"*Tramways.*—Mr. A. Westenholz has just secured a new concession to make about 5 miles of new electric street-railway line in the city of Bangkok, and has effected the consolidation of the present existing street-railway line, about 6 miles in length and operated by electricity, with the Electric Light Company, so that the present central lighting plant and the existing electric street-railway line and the new proposed line of about 4 miles will all be operated as the Siam Electricity Company, Ltd. Their capital will be about $500,000 gold.

"The electric power will be supplied by the lighting company, which will now run day and night, and some additional machinery will be required by the company for operating the new lines; also rails, ties, fastenings, insulators, and copper conductors.

"The existing line of about 6 miles in length will require, at the same time, to be relaid with new rails, as the present rails are about worn out.

"This work will probably be started at once."

The leading importers of electrical supplies in this city are the Siam Electricity Company, Ltd., the Siam American Trading Company, and the Bangkok Dock Company.

Medical Degrees in Germany.—Consul Hughes sends from Coburg, November 5, 1900, translation of the rules for conferring the degree of doctor of medicine which took effect October 1, as follows:

The degree of doctor of medicine can be conferred only after a thesis has been published and a verbal examination undergone. A "promotio in absentia" will not be allowed under any circumstances. By his thesis, the candidate must prove that he is able to work independently on scientific lines. The thesis must usually be written in German, though the use of another language may be allowed by the faculty. A biography of the candidate must be appended. The verbal examination consists either of a simple questioning or of an "Examen rigorosum." German subjects can not receive the degree before having obtained permission from the government to practise as a physician within the Empire.

By a unanimous vote of the faculty and with the permission of the supervising board, deviations from this rule may be granted in particular cases, in which the candidate can not, for weighty reasons, be expected to comply with them. Foreigners who have received the government permission to practise medicine within the German Empire are subject to the same regulations regarding their promotion to the degree of doctor of medicine as those laid down for German subjects. Foreigners who do not possess the permit for the German Empire and who wish to be promoted should lay before the faculty proofs of the following facts:

(1) That they have had the schooling required in their own country for passing the examination and receiving the degree; if in their own country fixed rules with regard to this matter do not exist, they will have to show certificates from home in which proof is given that their schooling is equal to that required for obtaining the matriculation certificate at a German "Realgymnasium."

(2) That they have passed through—

(*a*) Studies before a regularly organized medical faculty for as many semesters as are required in Germany for admittance to the regular medical examinations.

(*b*) That at least one of those semesters has been spent at the German university at which they wish to receive their degree.

This latter rule may be suspended if the candidate be well known to the faculty. The printed thesis, which must be produced before obtaining permission to appear for the degree examination, may, at the faculty's discretion, be replaced by a scientific work of the candidate which has already been printed and published.

Conditions in the German Iron and Steel Market.—For the last seven years the German iron industry has been steadily growing, the yearly increase in production during the last three years amounting to a trifle over 500,000 tons. During this period, owing to the ever-increasing demand, prices have also steadily risen, so that an exceptional period of prosperity was experienced. The increase in prices began to make itself especially felt in the year 1898, continued steadily during 1899, and reached its climax in May and June of the present year, when, owing partly to the enormous increase in the price of fuel and also to the tendency of buyers, who regarded any prospect of a fall in prices as out of the question, to insure their supplies for the whole year, prices reached their highest point. In the early part of the year, the United States and England were enabled, owing to their home markets being quieter, to supply the Continent at cheaper rates; but their markets and freights followed the general upward tendency. With the outbreak of the war in China, and also influenced by the protracted nature of the war in Africa, trade in general received a decided check toward the latter half of July, and since then the iron and steel market, in common with nearly everything else, has been falling steadily. At the present moment, the state of the Rhenish Westphalian and Siegerland markets is very unsatisfactory, makers in many cases forcing their customers to take delivery of the manufactured iron and steel they contracted for months ago, which tends to precipitate matters and force even firms that were thought to be quite sound to consider their position. The increase in the number of existing works has for the moment caused considerable overproduction as compared with the demand, and prices have still a downward tendency.

The high freight rates have been very prejudicial to the import of American material, but with the enormous increase of tonnage recently reported, freights have dropped considerably; and, as it seems likely that for some time the tonnage will be in excess of requirements, American exporters should have a good chance of competing successfully in the European markets, especially as the price of fuel still remains very high and at present shows no signs of falling to any appreciable extent.

Competition for all sorts of iron and steel is very keen, and the continual shrinkage in home and foreign contracts leaves larger quantities to be disposed of at the works than is at all desirable. At a meeting of the hoop-mill convention, which took place a short time ago, it was agreed to maintain the former price of 195 marks ($46.41) per ton; but offers are known to have been made by dealers at prices considerably below the list quotation. Rumors are current that, owing to an increase in the foreign demand, a fair amount of fresh work is likely to soon come to the rolling mills. The tube convention has resolved on a change of quotations, raising those of the best sorts, for which American competition need not be feared, while the prices for heavier sorts have been reduced. The South German rolling-mill convention has also reduced quotations and brought them on a level with those of the other German syndicates.

The depression has made itself most felt in the bolt, nut, rivet, and kindred trades, prices being at the present moment 60 per cent lower than in the summer and still falling, and makers being ready to accept orders at almost any price.

The large engineering and similar works are at present fairly well employed, but many smaller ones feel the depression and have to discharge some of their men; while the larger works all note a decrease of orders coming in, pointing to a slack time as soon as the work in hand is completed.

In conclusion, it may be remarked that the outlook at the present moment is not good, but it is a more or less natural outcome of overproduction and the generally unsettled state of politics the world over. Should the wars in Africa and China be brought to a speedy and satisfactory termination, it is probable that there will be a general improvement; and as long as freights remain low, there is an excellent chance for American iron and steel to obtain a good footing in the German market, although exporters will have to reckon with a growing tendency in this country to crush American competition at any cost, as it is now clearly realized that our country is Germany's most formidable rival for commercial supremacy.—Charles E. Barnes, Consul at Cologne.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Stove Polish.—Melt 12 parts of ceresine and 10 parts of Japanese vegetable wax. To the half-cooled, but still liquid, mass add a trituration of lampblack 12 parts and graphite 10 parts, with 100 parts of oil of turpentine, and stir until completely cooled off.—Oesterr. Farben und Lack-Zeitung.

Improved Luminous Mass.—According to experiments by Rodriguez-Mourelo, the following mixture gives an excellent luminous mass which, besides great luminosity retained for a long time, possesses the advantage of having to be exposed to the light only for a short time.

Mix 2 grammes of dehydrated sodium carbonate, 0.5 gramme of sodium chloride and 0.2 gramme of manganic sulphate with 100 grammes of strontium carbonate and 30 grammes of sulphur and heat three hours to a white heat with exclusion of air.—Moniteur Scientifique.

Eau de Toilette "Lubin."—Fr. Tollner gives the following receipt for the preparation of the above toilet water:

Tincture of tolu balsam	140.0
Tincture of orris root	300.0
Bergamot oil	10.0
Ylang Ylang oil	4.0
Vanillin	0.5
Tincture of musk	4.0
Spirit of wine (90 per cent)	550.0

Mix and filter. Pharmaceutische Zeitung.

To Pierce Rubber Nipples.—Levy recommends the following method to put small holes, preferably 3 to 4 in the nipples in a simple and practical manner, so that the milk does not enter the baby's mouth direct, but only by means of sucking motions. Take a little pointed piece of wood, for instance a toothpick, introduce it into the top of the nipple consisting of soft rubber and push it up so that a fold of about ½ to 1 cm. results. Next, the point of the pick is cut off, together with the thinly stretched out rubber layer, by means of a sharp scissors. In this manner a sharp-edged hole of the same size as in the feminine breast is obtained. Repeat the process according to the number of holes desired.—Munchener Medicinische Wochenscrift.

Bottle Wax Insoluble in Alcohol.—The bottle waxes constituting a mixture of resin, fillers and dyestuffs, as used heretofore, are soluble in spirit. But if the colophony used is transformed into the abietates of the alkaline earthy metals and heavy metals and the varnish is prepared with the aid of hydrocarbons of the earth oil, insoluble in alcohol, it is said to be absolutely insoluble in alcohol, resisting atmospheric influences, and hence preferable to other closures when it is desired to close up spirituous liquors hermetically. Aside from the control effected by the seal impression, the employment of an alcohol-insoluble is also of importance economically in that the rather considerable loss by evaporation of spirit, owing to poor closing agents, may now be lessened.—Pharmaceutische Zeitung.

Production of Waterproof Paper.—A new process patented in Austria concerns a composition which is to serve as a waterproof coating for paper, or as an admixture imparting waterproof properties to the paper. The mass consists of albuminous substances—albumen or gluten—of caoutchouc or gutta percha, or any caoutchouc or gutta percha substitute, or of linseed oil varnish.

If great flexibility is desired, glycerin, sirup, molasses, fat, oil, etc., may be added to the coat-mats. The coating is produced as described below:

Dissolve the albumen or the gluten, cold, in an equal quantity (by weight) of water or any other solvent. A solution of equal density is prepared by dissolving caoutchouc, gutta percha or their surrogates in benzine. These solutions are thoroughly mixed by hand or by machine, in varying proportions according to the purpose they are to be used for. In order to prevent the albumen or the gluten in the mixture from decomposing, a slight quantity of salicylic acid or carbolic acid is added.

For example, two mixtures are given, the second with substances for obtaining a greater pliancy, the first without.

	Parts by Weight.
1. Albumen or gluten	25
Water	25
Salicylic or carbolic acid	0.25
Caoutchouc or gutta percha, or their substitutes	3 to 10
2. Albumen or gluten	25
Water	25
Salicylic or carbolic acid	0.25
Glycerin, sirup, fat or oil	5 to 13
Caoutchouc	3 to 10

When the mixture is done the albumen contained therein is caused to coagulate; for instance, by drawing the paper coated with it through hot rollers. The albumen may also be coagulated before by heating the water in which it is dissolved. The coagulated albumen is then separated from the water and mingled with the other ingredients as enumerated. The caoutchouc used for the mixture or the gutta percha is vulcanized in the customary manner, but the vulcanizing may also be done before the coagulation of the albumen in the mixture. These processes can take place simultaneously, by adding the sulphur destined for the vulcanization to the caoutchouc solution before same is mixed with the albumen solution and heating the mixture.

The coating or saturating composition is thinned with benzine, turpentine, oil or other solvents, and thus applied by hand or machine on the paper to be waterproofed once or repeatedly after a thorough drying each time. The impregnating mass may be mixed with paper fibers in pulping machines, thus obtaining a mass suitable for the production of plastic waterproof articles.

Objects covered or impregnated with this mass are said to behave as though made waterproof with caoutchouc only.—Neueste Erfindungen und Erfahrungen.

THE

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TABLE OF CONTENTS.